THURSDAY, DECEMBER 18, 1919.

PHYSIOLOGY AND MEDICINE.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod. Assisted by Dr. Roy G. Pearce and by Others. Pp. xxxii+903. (London: Henry Kimpton, 1918.) Price 37*s.* 6*d.* net.

TEACHERS engaged in giving instruction in physiology to students of medicine are well aware of the difficulty pointed out in the preface to the book before us. The student, mainly out of ignorance, is apt to regard the subject as of no importance in the practice of his profession, and to devote what attention he gives to it simply to what he believes will enable him to pass some particular examinational test. He rarely acquires real and useful knowledge of the fundamental processes at the basis of all the manifestations of vital phenomena, normal and pathological, a knowledge which he usually regards as purely "academic." He fails to realise how great an assistance in the comprehension of complex states he would obtain by the application of such general principles. It is to be feared that this attitude is too much encouraged by that of some clinicians. The student learns from his friends who have passed on to their hospital work what little value physiology possesses, as judged by the remarks made by his clinical teachers. There are signs, however, that a change is taking place. The work of physiologists in elucidating problems which arose during the late war, such as the action of poison gases, the regeneration of muscle and nerve, wound-shock, and so on, had the effect of demonstrating to many enlightened medical officers the necessity of physiological science.

On the side of the physiologists themselves it is perhaps true to some extent, as the preface to Prof. Macleod's book states, that the laboratory courses fail to give the student the conviction that he is learning what will be of use to him in the future. But this conviction is not an easy matter to give, for the reason that the teacher, naturally enough, is not regarded as an impartial judge when he seeks to impress upon his students the bearing of any particular lesson upon the interpretation of disease. Prof. Macleod holds that the chief remedy of the evil "lies partly in the continuance of certain of the laboratory courses into the clinical years, and partly in the study of medical literature in which the application of physiology in the practice of medicine is emphasised." For the latter of these objects the present book is admirably fitted. The author intends it as "an advanced text-book in physiology for those about to enter upon their clinical instruction, and at the same time a review for those of a maturer clinical experience who may desire to seek the physiological interpretation of diseased conditions."

The practice of continuing some course of physiology during the clinical years is being advocated in certain quarters at the present time. A great difficulty is undoubtedly the enormous bulk of clinical knowledge that the unfortunate student has to learn. It would, perhaps, be a valuable step in this direction if the laboratories would arrange from time to time special lectures or practical exercises on aspects of the subject which happen to attract attention at the time, say, for example, "acidosis" and hydrogen-ion concentration at the present time. Suggestions would be made by the clinical teachers. On the other hand, this practice would not solve the problem of giving the student a vital interest in his laboratory work, and it has been suggested that some opportunity might be arranged for the student to see something of hospital work during his physiological course. A note in NATURE of May 15 last states that Sir Edward Sharpey Schafer objects to any systematic clinical instruction at this time. Doubtless with justice. But might it not serve the purpose if an occasional clinical demonstration, appropriate to the physiological problem under discussion, such as the taking of an electrocardiogram in a case of heart disease in connection with the treatment of electrical phenomena in muscle, were given in the hospital? It would, at all events, serve to show the student what he must learn, and impress upon him how little he knows. At the same time, much caution would need to be exercised to avoid the fatal error of limiting physiological teaching to what is obviously of immediate interest in clinical practice.

The book before us does not claim to supersede the general text-books, or to give instructions for the performance of chemical tests and estimations. These latter are only to be learned by practice. Indeed, it would seem that the word "biochemistry" in the title of the book might be omitted, because the author himself states that it treats biochemical knowledge from the viewpoint of the physiologist. Biochemistry, in fact, can scarcely be regarded as an independent science in the sense that physiology is. Its separate teaching and investigation are rather matters of practical convenience, and, unless guarded against, may lead to unfortunate results. Part of it is included in physiology, animal and plant, while the remaining part is a branch of organic chemistry.

Certain aspects of physiology, such as the phenomena of immunity and the details of reactions of the central nervous system, require the space of special works. Some readers may be inclined to think that the portion of Prof. Macleod's book devoted to the nervous system is somewhat meagre in comparison with that occupied in the usual text-books. It gives, however, an excellent general account of the activities of the nerve-centres, and we may call to mind that a large part of the corresponding sections in many text-books is occupied with pure anatomy. It is curious that Prof. Macleod falls into the common practice of describing the receptor organ for position, the semicircular canals, under the head of the cerebellum; but this is possibly to be accounted

for as the result of his intentional omission of details of the sense-organs in general, which would have made the book too unwieldy.

Since a review is scarcely complete without a word of criticism, it may be pointed out that the spelling of "edema" and "hemoglobin" is unwelcome to British eyes, and that "neuron" should have a final *e*.

But these are trivialities, and the work as a whole can be highly commended. Circulation, respiration, digestion, and metabolism are especially well discussed. There are, of course, some aspects of these questions on which our knowledge is more complete than at the time the book was written. These are matter for a future edition. In such an edition a short account of the phenomena of immunity, from a general point of view, would be valuable, although this would not be a particularly easy task. The illustrations and diagrams are by no means the least useful part of the book. W. M. BAYLISS.

MATHEMATICS, PARTICULAR AND GENERAL.

(1) *Analytic Geometry.* By Prof. Maria M. Roberts and Prof. Julia T. Colpitts. Pp. x + 245. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 7*s.* 6*d.* net.

(2) *Elementary Mensuration, Constructive Plane Geometry, and Numerical Trigonometry.* By P. Goyen. Pp. viii + 169. (London: Macmillan and Co., Ltd., 1919.) Price 3*s.* 6*d.*

(3) *Lectures on the Philosophy of Mathematics.* By James Byrnie Shaw. Pp. vii + 206. (Chicago and London: The Open Court Publishing Co., 1918.) Price 6*s.* net.

(1) PROFS. ROBERTS AND COLPITTS have wisely included in a single course on "Analytic Geometry" the most important parts of the theory of conic sections, the theory of curves in Cartesian and polar co-ordinates, and the elements of solid geometry treated analytically, thus representing as a connected whole the parts of co-ordinate geometry in which every university student of mathematics should be thoroughly grounded. The book is very sound pedagogically, the treatment being based largely on the intuitive use of geometrical constructions. The figures are well and neatly drawn, and many of the curves are accurately plotted.

One must, however, point out some of the more serious faults, with a view to their elimination from a future edition. Some of the figures are unsatisfactory—*e.g.* those on pp. 117, 136, 152, 159, 168, 178, and 188. A very important point is missed on p. 38. The student should be informed that in a family of curves like

$$ay^2 = x(x-2a)^2,$$

which can be written in the form

$$(y/a)^2 = (x/a)(x/a-2)^2,$$

the value of the parameter a is to indicate the dimension of any curve of the family, so that the family consists of similar curves with the origin as centre of similitude. The method of § 70 is clumsy.

An interesting feature is the discussion on pp. 83–4 of the difficulties arising from the multiple representation of points in the polar system. A definite point on a plane has definite Cartesian co-ordinates if the axes are given, but it has more than one pair of polar co-ordinates even when the pole and original line are given. Thus the points (ρ, θ), $(-\rho, \theta+\pi)$, $(\rho, \theta+2\pi)$, $(-\rho, \theta+3\pi)$, etc., are all really one and the same point. This may cause confusion and error in the practical use of polar co-ordinates. Unfortunately, the authors do not indicate clearly the steps to be taken in order to avoid the danger. This is done by writing any equation $\rho = f(\theta)$ in the more general form $\rho = (-)^n f(\theta + n\pi)$, in which n is any positive or negative integer.

The book is one that can be unhesitatingly commended to the notice of teachers and students. There are numerous exercises, amply illustrative of the principles taught.

(2) There is no doubt that Mr. Goyen is right in claiming for the experimental method of geometrical teaching the advantage of preparing "the way for such subsequent abstract proofs as will enable learners to reinforce the test of experience by the test of reason." The present book depends somewhat on the "test of experience," and its value lies principally in the information given, and not in the process of proof employed to establish the results. Occasionally, indeed, statements are made without attempt at any justification.

Mr. Goyen's book thus caters for the student who wishes to acquire geometrical knowledge rather than geometrical training. It includes the usual geometry of rectilinear figures and circles, with application to ordinary mensuration; the quadrilateral and regular and irregular polygons; and the use of similar figures and some three-dimensional mensuration. A welcome chapter is that on numerical trigonometry, a subject too much neglected in elementary mathematical teaching. Every student who claims to have "done mathematics" should be able to deal successfully with easy problems in "heights and distances."

There are numerous examples. The tables and the answers add to the usefulness of a very useful book.

(3) One of the great defects of scientific teaching, due no doubt to the high degree of specialisation that recent progress has made necessary, is the restricted outlook of the presentation. The pass student learns a certain amount of two or three subjects; the honours man studies one subject to a higher pitch of excellence; but both the pass and the honours men are generally ignorant of two important aspects of their studies: they know little of the historical development of their subjects, and they rarely acquire a view of the whole of any subject, the correlation of its parts,

its foundations, and the contemporary trend of its development.

The ignorance of the history of any science could easily be remedied. Each head of a scientific department should arrange for a historical course in his subject. The interest aroused by such an adequately prepared and well delivered and illustrated historical course would more than repay the time spent on it.

The acquisition of a competent view of any subject is more difficult, and especially in mathematics, as is illustrated by Dr. Shaw's lectures. No student of mathematics can be expected to be familiar with all or even with the majority of the branches of mathematics mentioned by Dr. Shaw. The pass man would probably lay the book down after reading the first chapter—if he gets thus far. The honours student would perhaps go further, particularly if his speciality is pure mathematics and his reading has been ably directed by a teacher familiar with modern mathematical tendencies. Yet Dr. Shaw has dealt with his theme in a particularly persuasive and very elementary manner.

The author considers the "speculative thinker" who desires "to know the content of mathematics," "to hunt for the central principle that controls its evergreen growth," to explore "the source of mathematical reality," and to discover the "methods pursued in the field of investigation" and the "right of this Queen of all the sciences to rule." These problems are dealt with in a brief and clear exposition, which must be read in order to be appreciated. It would be idle to attempt a summary, as this would not convey much to the uninitiated for whom the lectures were written. Suffice it to say that in Dr. Shaw's opinion there is no *single* principle of mathematics, no *single* source of reality, no *single* mathematical method.

These lectures should be read and re-read by all who desire to fathom the depths of the reality of mathematics. They will be inspired to a view of the subject different from the drab and utilitarian view so often prevalent in our colleges. They will learn at least to give his due share of recognition to the mathematician who "sits with abstracted mien, his mental eye turned inward upon some intricate construction of symbols and formulæ," and to respect, perhaps even to share, his joy when he catches the flash of triumph.

S. BRODETSKY.

OUR BOOKSHELF.

The Journal of the Institute of Metals. Vol. xxi. Edited by G. Shaw Scott. Pp. xi + 508 + 40 plates. (London: The Institute of Metals, 1919.) 31*s.* 6*d.* net.

OF the new volume of this important journal, no fewer than 216 pages are occupied by the fourth report to the Corrosion Committee by Drs. Bengough and Hudson and the subsequent discussion. The new report embodies the results of a very large amount of experimental work, and is distinctly helpful in regard to the immediate problem of extending the life of brass condenser tubes. A large array of new facts bearing on the baffling question of the mechanism of corrosion is also included, and illustrated by numerous plates. The authors favour the view that direct oxidation takes place without preceding electrolytic action. As Prof. Armstrong points out in the discussion, the theory of corrosion is in a disappointingly backward state, and no satisfactory explanation has yet been given of some of the most familiar facts. The report is a valuable one, and fully justifies the continuance of the work of the committee.

Messrs. Hanson and Archbutt contribute a most useful account of their methods of polishing and etching aluminium and its light alloys, and of identifying the constituents, a task which has presented difficulties to most metallographers. Another paper from the same laboratory, by Dr. Rosenhain and Mr. Hanson, records the properties of some copper alloys which were devised for war purposes, and incidentally describes a convenient method of obtaining clean castings by working under pressure. A note by Lt.-Col. Jenkin on the metallurgical information required by engineers is followed by a lively discussion, the conclusion being reached that the determination of true physical constants is likely to supersede many of the present empirical tests. There are two papers on the effect of cold work on metals, and an interesting discussion on the relation of science to the industry of the non-ferrous metals, in which the respective views of scientific workers and manufacturers are well and clearly expressed. The volume concludes with the usual abstracts of metallurgical literature.

C. H. D.

Golden Days from the Fishing-Log of a Painter in Brittany. By Romilly Fedden. Pp. xviii + 233. (London: A. and C. Black, Ltd., 1919.) Price 7*s.* 6*d.* net.

HERE is a book full of quiet charm and humour, written by one who is evidently not only an artist and a sportsman, but also a true lover and observer of Nature and her ways. The angler will be fascinated by the vivid descriptions of trout- and salmon-fishing in Brittany. There are no improbable fisherman's yarns to invite his scepticism, but their place is taken by some delightful stories of saints and miracles drawn from the Breton folk-lore, so that the book appeals quite as much to the general reader as to the piscatorial fraternity. It is a pleasant narrative, well suited to while away a winter evening at the fireside and to conjure up visions of sunlit meadows, fragrant pinewoods, and murmuring streams, though tinged, alas! by that vein of sadness which must colour the day-dreams of all of us at the present time, and especially of those who, like the author, have witnessed at close quarters the tragedy of the last few years.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Power from the Sun.

In the very interesting Trueman Wood lecture delivered at the Royal Society of Arts on December 10, Sir Oliver Lodge discussed the utilisation of solar radiation, and recommended, as the best method of effecting this purpose, the promotion of agriculture of every kind. According to Sir Oliver Lodge, the green leaves of trees and vegetables generally are able to absorb and utilise solar energy without much regard for any hampering limit to efficiency such as the second law of thermodynamics, but in saying this he appears to be unaware of the researches of Dr. Horace Brown, who has shown that the actual amount of energy stored is less than 2 per cent. of that which reaches the vegetation.

Now the total amount of solar energy intercepted by the earth is prodigious, being in the aggregate some 200 billion h.p., or, on an average, about 4,000,000 h.p. per square mile of that portion of the earth's surface that is exposed not too obliquely to the sun's rays. Absorption by the clouds and by the atmosphere, though important, is not so great as might be expected, with the result that even in this latitude and in this climate the energy constantly received throughout the hours of daylight exceeds 1000 h.p. per acre.

If, then, some method could only be devised for efficiently converting this energy into a form in which it could be readily applied for motive power and other purposes, the gain and the convenience would be enormous; for, to take a single instance, sufficient energy to run all the machinery in a factory throughout the working day could be collected from an area in many cases not greater than that subtended by the factory's roof.

Now, of course, for reasons which Sir Oliver Lodge fully discussed, it is hopeless to expect to be able to effect anything of this nature with the heat engine, for with this we should scarcely reach the 2 per cent. efficiency nearly attained by vegetation. But is there any need to allow the radiation to turn itself into heat at all? Solar radiation, as is well known, consists of electromagnetic waves in the æther—waves exactly similar in kind to those employed in wireless telegraphy. The only difference is that, whereas the length of the waves used in wireless telegraphy is a matter of hundreds or thousands of metres, the wavelength in the case of solar radiation is only a very minute fraction of a millimetre.

Even with wireless waves the resulting frequency is too great to allow of the electric currents they induce being directly utilised. The telephones and other instruments employed offer too much impedance to allow such currents to pass, while, apart from this, no mechanical device could move with sufficient rapidity to respond to such frequencies. In wireless telegraphy, however, a method has been devised for converting these rapidly alternating or oscillating electric currents into currents which, though pulsating, are unidirectional. This is accomplished by the application of thermionic or crystal rectifiers or non-return valves, which only allow the currents in one direction to pass and suppress altogether the currents in the opposite direction. In this way the comparatively useless high-frequency oscillatory currents are converted into rapidly pulsating unidirectional currents which behave like continuous currents, and will operate telephones and other electromagnetic devices. Moreover, though in wireless telegraphy it is customary to use the currents in a single direction only, and to suppress the inverse currents altogether, there is no difficulty about utilising both currents by turning them into separate circuits with valves set opposite ways. Under such conditions, seeing that the separate valves let through their respective currents with but little loss, the efficiency of the conversion from the radiant energy absorbed to that utilisable in the form of electric current is quite high, probably not less than 50 per cent., and perhaps considerably more.

Is it too rash to suggest the possibility of some analogous method being applicable to convert into utilisable electric currents the electromagnetic waves of which the radiant energy from the sun consists? The method is quite successful with wireless waves having frequencies of millions per second, but can it be applied to the sun's waves, the frequency per second of which is of the order of billions? No doubt the problem is a difficult one, but we live in an age of marvels, and what would have been said of modern wireless methods only a few years ago?

One thing seems certain. The energy in the sun's radiation is there, and there, too, in most abundant quantity. To make use of it, moreover, requires no Maxwellian "demon" such as is necessary to render available the general stock of heat energy at uniform temperature. Nor, again, does what is suggested run counter to any thermodynamical law such as would preclude full advantage being taken of the great efficiency that is rendered possible by the enormous temperature of the sun.

Anyway, the problem of the application of solar radiation to the production of power otherwise than by means of heat engines seems worthy of attention, and is a problem that would appear much more likely to meet with a speedy solution than the difficult and obscure question of the liberation and utilisation of the internal energy of the atom.

A. A. Campbell Swinton.
66 Victoria Street, London, S.W.1,
December 15.

Heat of Reaction and Gravitational Field.

A simple relation between the variation of mass in a physical change of state or chemical reaction and the rate of variation with gravitational potential of the corresponding change of total internal energy can be deduced as follows:—Let m_1 and m_2 denote the masses of the initial and final states of the chemical system and Q the heat evolved, say at constant temperature and pressure, and at the gravitational potential Z. Considering the following isothermal cycle:

(*a*) State 1 to state 2 at Z,
(*b*) State 2 at Z to state 2 at $Z+\delta Z$,
(*c*) State 2 to state 1 at $Z+\delta Z$,
(*d*) State 1 at $Z+\delta Z$ to state 1 at Z,

and equating the total change of energy to zero, we get the equation

$$\left(\frac{\partial Q}{\partial Z}\right)_{p,t} = m_1 - m_2.$$

For all ordinary reactions, experiment has shown that m_1-m_2, if not zero, must be very small. It follows, however, from the theory of relativity that if the reaction be exothermic $m_1>m_2$, whilst if it be endothermic $m_1<m_2$. Hence in the former case $\frac{\partial Q}{\partial Z}$ is positive, whilst in the latter case it is negative. If we can apply the energy theory to the highly exenergic

radio-active changes, it would follow that the energy given out in such changes must be greater in strong gravitational fields than in weak.

F. G. DONNAN.

University College, London, December 10.

A Helium Series in the Extreme Ultra-Violet.

IN NATURE for November 20 Prof. Lyman reports his observation of a helium line at 1640·1, as well as a weak one at 1215·1, close to the strong one 1216, and refers them to orders 3, 4 in the series $4N\{1/2^2 - 1/m^2\}$. If the correct reading for the strong line is nearer the 1215·1, the whole series $m=4 \ldots 8$ is found in his list of ultra-violet lines given in the *Astro. Journ.* (vol. xliii., p. 89, 1916). The following is the list of observed lines with deviations (obs.–calc.) from the calculated values, with N = 109720 :—

Order	Intensity	λ	dλ
3	strong	1640·2	−0·34
4	10	1215·1	−0·11
5	5	1086·1	+1·08
6	4	1026·0	+0·66
7	3	992·0	−0·37
8	1	972·7	+0·59

The line 1084·9 is closer to the calculated with $d\lambda = -0{\cdot}11$, but its intensity of 2 is not in step with the others. In estimating possible errors, those of standards as well as of observation have to be considered. With uncertainties also of formula, the values of $d\lambda$ do not seem excessive.

W. M. HICKS.

Crowhurst, December 11.

The Constitution of the Elements.

IT will doubtless interest readers of NATURE to know that other elements besides neon (see NATURE for November 27, p. 334) have now been analysed in the positive-ray spectrograph with remarkable results. So far oxygen, methane, carbon monoxide, carbon dioxide, neon, hydrochloric acid, and phosgene have been admitted to the bulb, in which, in addition, there are usually present other hydrocarbons (from wax, etc.) and mercury.

Of the elements involved hydrogen has yet to be investigated; carbon and oxygen appear, to use the terms suggested by Paneth, perfectly "pure"; neon, chlorine, and mercury are unquestionably "mixed." Neon, as has been already pointed out, consists of isotopic elements of atomic weights 20 and 22. The mass-spectra obtained when chlorine is present cannot be treated in detail here, but they appear to prove conclusively that this element consists of at least two isotopes of atomic weights 35 and 37. Their elemental nature is confirmed by lines corresponding to double charges at 17·50 and 18·50, and further supported by lines corresponding to two compounds HCl at 36 and 38, and in the case of phosgene to two compounds COCl at 63 and 65. In each of these pairs the line corresponding to the smaller mass has three or four times the greater intensity.

Mercury, the parabola of which was used as a standard of mass in the earlier experiments, now proves to be a mixture of at least three or four isotopes grouped in the region corresponding to 200. Several, if not all, of these are capable of carrying three, four, five, or even more charges. Accurate values of their atomic weights cannot yet be given.

A fact of the greatest theoretical interest appears to underlie these results, namely, that of more than forty different values of atomic and molecular mass so far measured, all, without a single exception, fall on whole numbers, carbon and oxygen being taken as 12 and 16 exactly, and due allowance being made for multiple charges.

Should this integer relation prove general, it should do much to elucidate the ultimate structure of matter. On the other hand, it seems likely to make a satisfactory distinction between the different atomic and molecular particles which may give rise to the same line on a mass-spectrum a matter of considerable difficulty.

F. W. ASTON.

Cavendish Laboratory, December 6.

The Deflection of Light during a Solar Eclipse.

THE fall of temperature that may occur in the higher strata of the atmosphere during an eclipse is somewhat doubtful, but can scarcely exceed half a degree. An attempt was made to measure it directly during the partial, but nearly total, eclipse in England on April 17, 1912, but of the instruments sent up one only was recovered, so that no comparison could be made.

On the average, the solar heat absorbed by the earth's surface and the atmosphere during one day is capable of raising the whole atmosphere about 1·5° C., and, of course, about the same amount must be lost per day by radiation. There is direct evidence that the daily change of temperature as we know it at the surface does not extend to more than 1 km. or 2 km., and from 2 km. to 20 km. the daily range can scarcely reach 1° C. In these circumstances the fall of temperature of the upper strata during an eclipse must be small, say ¼° or ½° at the outside.

Our direct observations of atmospheric temperature very seldom exceed 20 km., and above that height we know neither the value nor the changes to which it is subject. This is perhaps of little consequence since at 20 km. more than 94 per cent. of the whole mass has been passed.

It must also be remembered that the line of lowest temperature will not be the axis of the shadow-cone, but will lag considerably behind it.

W. H. DINES.

Benson Observatory, Wallingford.

THE correction to the Einstein effect indicated by Mr. W. H. Dines's estimate of the depression of temperature in the eclipse shadow is even less than 10^{-11} radians or 10^{-6} seconds of arc. For a vertical ray the deflection caused by a horizontal temperature-gradient of $d\theta°$ C. in dx cm. is approximately

$$(\mu - 1)_G \cdot H \cdot \frac{d \log_e \theta}{dx},$$

where $(\mu-1)_G = 28 \times 10^{-5}$ is the refractivity of air at normal density, and H is the height of the homogeneous atmosphere. For two rays at a mean distance in the atmosphere of a kilometre apart—a liberal estimate—the difference in deflection would be in c.g.s. units

$$28 \times 10^{-5} \times H \times 10^5 \cdot d^2 \log \theta / dx^2.$$

If the shadow may be considered to have a radius of 500 km., then $d^2 \log \theta / dx^2$ would be of the order of 10^{-18}. From this the initial statement follows.

That is, assuming $\partial H / \partial x = 0$. But more simply conveniently, and accurately the bending of a vertical ray can be expressed in terms of the surface pressure-gradient because the refractivity is simply proportional to the density. So that five barometers, one at the eclipse station and four distributed around it, would yield the corrections for a single ray. The bending

comes to $2{\cdot}3\times10^{-4}\ \partial p/\partial x$ radians, where p is the surface pressure in dynes cm.$^{-2}$ and dx is in cm.

LEWIS F. RICHARDSON.

Benson Observatory, Wallingford,
December 12.

I, OF COURSE, admit the force of the remarks in the letters which appeared in NATURE of December 11. But the problem of air refraction during a total eclipse is a very complicated one. The air is not in equilibrium. There is, I imagine, a downward rush of cold air in places deprived of the sun's radiation, as well as a lateral motion of the air from all sides towards such places. The whole refraction effect depends on the shape of the changing surfaces of equal density, and the gradient of density perpendicular to these surfaces. The effect observed would be about equal to the ordinary refraction effect caused by the atmosphere at $1\frac{1}{3}°$ from the zenith, and then the rays of light are nearly perpendicular to the surfaces of equal density.

It is well to remember that, perhaps unfortunately, the stars in the neighbourhood of the sun during a total eclipse must be viewed through air of which the distribution of density must not be assumed to be the same as that of the atmosphere in its normal state.

ALEXR. ANDERSON.

EINSTEIN'S RELATIVITY THEORY OF GRAVITATION.[1]

III.—THE CRUCIAL PHENOMENA.

IN the article last week an attempt was made to indicate the attitude of the complete relativist to the laws which must be obeyed by gravitational matter. The present article deals with particular conclusions.

As Minkowski remarked in reference to Einstein's early restricted principle of relativity: "From henceforth, space by itself and time by itself do not exist; there remains only a blend of the two" ("Raum und Zeit," 1908). In this four-dimensional world that portrays all history let (x_1, x_2, x_3, x_4) be a set of co-ordinates. Any particular set of values attached to these co-ordinates marks an event. If an observer notes two events at neighbouring places at slightly different times, the corresponding points of the four-dimensional map have co-ordinates slightly differing one from the other. Let the differences be called (dx_1, dx_2, dx_3, dx_4). Einstein's fundamental hypothesis is this: there exists a set of quantities g_{rs} such that

$$g_{11}dx_1^2+2g_{12}dx_1dx_2+\ \ldots\ +g_{44}dx_4^2$$

has the same value, no matter how the four-dimensional map is strained. In any strain g_{rs} is, of course, changed, as are also the differences dx.*

If the above expression be denoted by $(ds)^2$, ds may conveniently be called the *interval* between two events (not, of course, in the sense of time interval). In the case of a field in which there is no gravitation at all, if dx_4 is taken to be dt, it is supposed that ds^2 reduces to the expression $dx_1^2+dx_2^2+dx_3^2-c^2dt^2$, where c is the velocity of light. If this is put equal to zero, it simply expresses the condition that the neighbouring events correspond to two events in the history of a point travelling with the velocity of light.

Einstein is now able to write down differential equations connecting the quantities g_{rs} with the co-ordinates (x_1, x_2, x_3, x_4), which are in complete accord with the requirement of complete relativity.[2] These equations are assumed to hold at all points of space unoccupied by matter, and they constitute Einstein's law of gravitation.

Planetary Motion.

The next step is to find a solution of the equations when there is just one point in space at which matter is supposed to exist, one point which is a singularity of the solution. This can be effected completely[3]: that is, a unique expression is obtained for the interval between two neighbouring events in the gravitational field of a single mass. This mass is now taken to be the sun.

It is next assumed that in the four-dimensional map (which, by the way, has now a bad twist in it, that cannot be strained out, all along the line of points corresponding to the positions of the sun at every instant of time) the path of a particle moving under the gravitation of the sun will be the most direct line between any two points on it, in the sense that the sum of all the intervals corresponding to all the elements of its path is the least possible.[4] Thus the equations of motion are written down. The result is this:

The motion of a particle differs only from that given by the Newtonian theory by the presence of an additional acceleration towards the sun equal to three times the mass of the sun (in gravitational units) multiplied by the square of the angular velocity of the planet about the sun.

In the case of the planet Mercury, this new acceleration is of the order of 10^{-8} times the Newtonian acceleration. Thus up to this order of accuracy Einstein's theory actually arrives at Newton's laws: surely no dethronement of Newton.

The effect of the additional acceleration can easily be expressed as a perturbation of the Newtonian elliptic orbit of the planet. It leads to the result that the major axis of the orbit must rotate in the plane of the orbit at the rate of $42{\cdot}9''$ per century.

Now it has long been known that the perihelion of Mercury does actually rotate at the rate of about $40''$ per century, and Newtonian theory has never succeeded in explaining this, except by *ad hoc* assumptions of disturbing matter not otherwise known.

Thus Einstein's theory almost exactly accounts

[1] Previous articles appeared in NATURE of December 4 and 11.

[*] The gravitational field is specified by the set of quantities g_{rs}. When the gravitational field is small, these are all zero, except for g_{44}, which is approximately the ordinary Newtonian gravitational potential.

[2] These equations take the place of the old Laplace equation $\nabla^2V=0$. Just as that equation is the only differential equation of the second order which is entirely independent of any change of ordinary space co-ordinates, so Einstein equations are uniquely determined by the condition of relativity.

[3] The result is that the invariant interval ds is given by

$$ds^2=(1-2m/r)(dt^2-dr^2)-r^2(d\theta^2+\sin^2\theta d\phi^2),$$

the four co-ordinates being now interpreted as time and ordinary spherical polar co-ordinates.

[4] This corresponds to the fact that in a field where there is no acceleration at all the path of a particle is the shortest distance between two points.

for the one outstanding failure of Newton's scheme, and, we may note, does not introduce any discrepancy where hitherto there was agreement.

The Deflection of Light by Gravitation.

The new theory having justified itself so far, it was thought worth while for British astronomers to devote their main energies at the recent solar eclipse to testing its prediction of an entirely new phenomenon.

As was remarked above, the propagation of light in the ordinary case of freedom from gravitational effect is represented by the equation $ds=0$.

This Einstein boldly transfers to his generalised theory. After all, it is quite a natural assumption. The propagation of light is a purely objective phenomenon. The emission of a disturbance from one point at one moment, and its arrival at another point at another moment, are events distinct and independent of the existence of an observer. Any law that connects them must be one which is independent of the map the observer uses; ds being an invariant quantity, $ds=0$ expresses such an invariant law.

This leads at once to a law of variation of the velocity of light in the gravitational field of the sun.

$$v=c(1-2m/r).$$

Here m, as before, is the mass of the sun in gravitational units, and is equal to 1·47 kilometres, while c is the velocity of light at a great distance from the sun. Thus the path of a ray is the same as that if, on the ordinary view, it were travelling in a medium the refractive index of which was $(1-2m/r)^{-1}$. In this medium the refractive index would increase in approaching the sun, so that the rays would be bent round towards the sun in passing through it. The total amount of the deflection for a ray which just grazes the sun's surface works out to be 1·75″, falling off as the inverse of the distance of nearest approach.

The apparent position of a star near to the sun is thus further from the sun's centre than the true position. On the photographic plate in the actual observations made by the Eclipse Expedition the displacement of the star image is of the order of a thousandth of an inch. The measurements show without doubt such a displacement. The stars observed were, of course, not exactly at the edge of the sun's disc; but on reduction, allowing for the variation inversely as the distance, they give for the bend of a ray just grazing the sun the value 1·98″, with a probable error of 6 per cent., in the case of the Sobral expedition, and of 1·64″ in the Principe expedition.

The agreement with the theory is close enough, but, of course, alternative possible causes of the shift have to be considered. Naturally, the suggestion of an actual refracting atmosphere surrounding the sun has been made. The existence of this, however, seems to be negatived by the fact that an atmosphere sufficiently dense to produce the refraction in question would extinguish the light altogether, as the rays would have to travel a million miles or so through it. The second suggestion, made by Prof. Anderson in NATURE of December 4, that the observed displacement might be due to a refraction of the ray in travelling through the earth's atmosphere in consequence of a temperature gradient within the shadow cone of the moon, seems also to be negatived. Prof. Eddington estimates that it would require a change of temperature of about 20° C. per minute at the observing station to produce the observed effect. Certainly no such temperature change as this has ever been noted; and, in fact, in Principe, at which the Cambridge expedition made its observations, there was practically no fall of temperature.

Gravitation and the Solar Spectrum.

It was suggested by Einstein that a further consequence of his theory would be an apparent discrepancy of period between the vibrations of an atom in the intense gravitational field of the sun and the vibrations of a similar atom in the much weaker field of the earth. This is arrived at thus. An observer would not be able to infer the intensity of the gravitational field in which he was placed from any observations of atomic vibrations in the same field: that is, an observer on the sun would estimate the period of vibration of an atom there to be the same that he would find for a similar atom in the earth's field if he transported himself thither. But on transferring himself he automatically changes his scale of time; in the new scale of time the solar atom vibrates differently, and, therefore, is not synchronous with the terrestrial atom.

Observations of the solar spectrum so far are adverse to the existence of such an effect. What, then, is to be said? Is the theory wrong at this point? If so, it must be given up, in spite of its extraordinary success in respect of the other two phenomena.

Sir Joseph Larmor, however, is of opinion that Einstein's theory itself does not in reality predict the displacement at all. The present writer shares his opinion. Imagine, in fact, two identical atoms originally at a great distance from both sun and earth. They have the same period. Let an observer A accompany one of these into the gravitational field of the sun, and an observer B accompany the other into the field of the earth. In consequence of A and B having moved into different gravitational fields, they make different changes in their scales of time, so that actually the solar observer A will find a different period for the solar atom from that which B, on the earth, attributes to his atom. It is only when the two observers choose so to measure space and time that they consider themselves to be in identical gravitational fields that they will estimate the periods of the atoms alike. This is exactly what would happen if B transferred himself to the same position as A. Thus, though an important point remains to be cleared up, it cannot be said that it is one which at present weighs against Einstein's theory.

E. CUNNINGHAM.

THE INHERITANCE OF THE NAVAL OFFICER.[1]

IT seems good sense to say that a man who dislikes the sea and all that therein is, who has no spirit of adventure, who is, in short, a low-spirited land-lubber, is not in the least likely to make a distinguished naval officer. You never can tell, of course, for Nelson was always sea-sick and often pessimistic, but the chances are against a man such as we have pictured becoming a bright and shining light in the Navy. And that is what Dr. Davenport and his assistant have said, only they have said it very learnedly with a lot of technicalities about "thalassophilia," "hyperkinetism," "nomadism," and "recessives." The study of heredity does not foster a sense of humour, and we cannot wonder. It is a rather dismal science.

But the memoir before us goes much further than we have indicated. It is argued from sixty-eight biographies that distinguished naval officers have clear-cut special gifts, which are more or less Mendelian characters. They are expressed in the lineage, direct or collateral, and likewise find appropriate expression in early youth. If the number sixty-eight affords a sufficiently broad basis for secure induction, and if such characters as a love for the sea are really crisply defined, non-blending, unit characters, then the conclusions reached are of high interest. Both for theory and for action it is very important to know how much a man is made and how much he is born, and this latest product of the industry and enthusiasm of the Cold Spring Harbour laboratory for the experimental study of evolution and heredity is a contribution to the answer to this question. We should notice that, apart from the non-inclusion of those distinguished officers whose biographies failed to furnish any details of lineage or of boyhood, no selection of names was made. Dr. Davenport set out without any theory save the preconception which previous studies have warranted, that the hereditary make-up of a distinguished man is likely to include definite traits, being not so much a melange as a mosaic.

What, then, are the features which may be regarded as part of the natural inheritance of a distinguished naval officer, as contrasted with, let us say, a distinguished clergyman? The first is a love for the sea, a specific susceptibility to its call, a "thalassophilia." Unless this, or some analogous characteristic, such as nomadism, is in the blood, the chances are against the boy becoming a distinguished naval officer. Such is the verdict of biography. The second feature is some form of the spirit of adventure, a willingness to incur responsibilities, a capacity for rapid decision and action in face of difficulties. A few cases of persistent sea-sickness in admirals may be found—Nelson's is known to all—but there seems to be no instance of a distinguished naval officer without some form of the spirit of adventure. Very rarely has it taken the form of quarrelsomeness, or of pugnacity, or of devil-may-care rashness—though instances of these are well known—but a distinguished naval officer without the quality at all is a contradiction in terms. The third character that is normally present is the sanguine or buoyant temperament, which is technically described as hyperkinetic in contrast to the melancholic and fatalistic hypokinetic. Now, it is an interesting fact that a small minority among the sixty-eight were of the hypokinetic type—reserved, taciturn, melancholic, fatalistic—and that two or three of the greatest were strange mixtures of both, like Nelson, passing from the crests to the troughs of temperamental waves, probably enough correlated with changes in blood-pressure that would kill an ordinary man. But the great majority of the famous sea-captains have been markedly hyperkinetic, not only daring pilots when the waves ran high, but also positively defiant in danger.

As it seems to us, Dr. Davenport is too readily satisfied with the evidence that this or that character exhibits Mendelian inheritance, and that he attaches far too little importance to the family tradition and conversation in defining the lines of a boy's development; but he states a strong case in support of the view, which is more convincing in negative than in positive form, that "unless a love of the sea appears on at least one side of the house, hyperkinesis in at least one parent, or, in the case of an eminent naval man, among the male relatives of the mother, one is justified in doubting if the applicant for a naval commission will become an eminent officer." It is easy enough to make fun of this contribution to "the pedigree of the sea-dogs," but the number of round men in square holes is one of the tragedies of the world, and we wonder gravely how long it will be before wasteful methods of selection are replaced by those suggested by expert study of lineage and of childhood. As Mahan once said—and he had a great knowledge of naval officers—"Each man has his special gift, and to succeed must act in accordance with it." Dr. Davenport's memoir is a contribution to the art of discovering special gifts, or of estimating the probability of their presence.

[1] "Naval Officers: Their Heredity and Development." By Charles Benedict Davenport and Mary Theresa Scudder. Publication No. 259 Pp. iv+216. (Carnegie Institution of Washington, 1919.)

NOTES.

THE newspapers have lately published a big-game hunter's report that a gigantic dinosaurian reptile related to the extinct Brontosaurus and Diplodocus has been seen living in the Congo region of Africa. Palæontologists, however, receive the story with incredulity, and are decidedly of opinion that it must be founded on mistaken observations. The Dinosauria and all their gigantic reptilian contemporaries, whether on land, in the sea, or in the air, disappeared from every part of the world at the end of the Cretaceous period. If any had survived, some fragments of them would ere this have been found in the Tertiary formations which record the progress of life between that period and the present day. It is no contrary argument to quote Sir Harry Johnston's discovery of the okapi in the Congo forest, for this is merely a kind of ancestral giraffe which is known by fossils to have

existed so far north as Greece so recently as the beginning of the Pliocene Tertiary. The okapi is a congruous African animal, but a dinosaur would be an anachronism.

IN his Trueman Wood lecture delivered before the Royal Society of Arts on December 10, Sir Oliver Lodge dealt with "Sources of Power Known and Unknown." Power or energy, he said, is the most pressing material need of man. His entire material activity consists in moving matter, and food is mainly used by an animal for developing energy before it has assumed the form of heat. The best engines hitherto devised leave much to be desired in that respect. Even the internal-combustion engine is imperfect so long as it requires a cooling jacket. By the second law of thermodynamics, heat is most efficiently utilised at the highest temperatures. The sun's temperature being 6000° C. approximately, its direct utilisation would offer an efficiency closely approaching unity. The leaves of trees, and vegetables generally, are able to absorb and utilise solar energy in producing wood, coal, and food, and they seem to be able to do this without much regard to any hampering law of efficiency. There are two sources of energy not derived from the sun—the internal heat of the earth and the tides. A beginning has been made in utilising volcanic heat in Italy, but the utilisation of tides involves a use of reclaimed land which might be more valuable for other purposes. Dealing finally with atomic energy, Sir Oliver Lodge gave an admirably lucid account of the "planetary" atom on the basis of Bohr's model, showing that electrons can be "evaporated" or ejected with comparative ease, whereas the projection of an α-particle amounts to a veritable explosion. So far, the vast store of atomic energy becomes available only in radio-active substances, and this is already utilised for therapeutic and other purposes. There is, however, the control of electrons emitted from hot bodies, which has been brilliantly applied to the construction of "valves" for many electric purposes, among them being long-distance wireless telephony.

THE successful termination of Capt. Ross-Smith's flight from Hounslow to Port Darwin marks a great advance in the history of aeronautics, and is a good omen for the future of commercial aviation. This remarkable accomplishment leaves no doubt as to the possibilities of the aeroplane with regard to rapid transit to distant parts of the earth, especially when it is noted that the weather conditions were by no means good over the greater portion of the route. The machine used was a Vickers "Vimy," fitted with two Rolls-Royce "Eagle" engines of 350 horse-power each, and the greatest credit is due to the two firms for the remarkable endurance of their products under very trying conditions of both flying and landing. The difficulties attending such a flight are very different from those of the trans-Atlantic journey. In the latter case an endurance of 2000 miles without landing was essential, involving the carrying of an enormous load of fuel. The cross-country route to Australia, on the other hand, provided many possible landing places, but endurance of a different kind was necessary, inasmuch as the machine had to fly day after day with little time for attention and repairs, if the flight was to be completed within the specified time limit. Capt. Ross-Smith left Hounslow on November 12 and reached Port Darwin on December 10, having traversed a distance of 11,294 miles, steady progress being maintained throughout the flight. The feat will rank as one of the greatest in the development of the aeroplane, and the heartiest congratulations are due to the pilot and his companions for their remarkable addition to the list of aeronautical triumphs.

ON Monday, December 15, one of the galleries of the new building for the Science Museum, South Kensington, was opened for the exhibition of the existing aeronautics section of the collections and for the development of that section by additions which are being selected under the guidance of a number of expert advisers. The occasion was marked by the formal presentation of the Vickers "Vimy" Rolls-Royce aeroplane which crossed the Atlantic. In the absence of the President of the Board of Education, Dr. Ogilvie, Director of the museum, took the chair and referred briefly to the building scheme which had been put in hand for the museum in 1913, but was interrupted by the war. The gallery now occupied was, he said, in the temporary state in which it had been used for war purposes; it was, however, spacious and well-lit, and its use by the museum for a time now would give an opportunity of preparing a more adequate representation of the applications of science in aeronautics. Sir Richard Glazebrook, a member of the Advisory Council for the museum, reviewed recent progress in aviation, and stated that if this country was to hold the place it had taken in the forefront of aeronautics a complete exposition of the subject must be made available for reference in a central museum, such as the Science Museum. It was a matter for great gratification that the Government was giving serious attention to the promotion of research, and one of the functions of the museum was to aid in this by bringing together examples of the ways in which science gave help to industry and commerce. In presenting the aeroplane to the nation, Mr. Douglas Vickers, for Messrs. Vickers, Ltd., explained that it was one of the Vickers "Vimy" machines—bombing machines to carry a crew of three and a ton of bombs for 1000 miles on a non-stop flight. That standard machine had been varied only so as to take, instead, a crew of two with fuel for a journey of 2500 miles.

MR. W. WALKER has been appointed Chief Inspector of Mines in succession to Sir Richard Redmayne, whose impending resignation we announced last week.

MR. T. W. READER has been selected by the Geologists' Association as the first recipient of the Foulerton award. The sum of money which has enabled the association to make this award is the recent generous gift of Miss Foulerton in accordance with the wishes of her late uncle, Dr. John Foulerton, who was for many years secretary to the association.

PROF. H. G. GREENISH, Dean of the Pharmaceutical Society's School of Pharmacy, has, we learn from the *Pharmaceutical Journal*, been nominated by the Board of Professors of l'École Supérieure de Pharmacie de Paris as one of five foreign men of science upon whom the University of Paris has decided to confer the diploma of "Docteur *honoris causa*" on the occasion of "Une Séance Solennelle de rentrée pour fêter le retour des étudiants des diverses Facultés," on Saturday, December 20.

ON Wednesday, December 10, a memorial tablet with a medallion portrait and a suitable inscription was unveiled in memory of Sir William Ramsay in the presence of Lady Ramsay and a large number of friends and members of the University of Glasgow. The address of presentation was delivered by Prof. G. G. Henderson, of the Regius chair of chemistry, and the custody of the memorial was accepted on behalf of the University Court by the Vice-Chancellor. The medallion is the work of Mr. Paulin, and is an excellent likeness; the design of the memorial is due to Sir John J. Burnet. The mural tablet is placed at the head of the great staircase leading to the Bute Hall and the Hunterian Museum. It is set in an arched recess lined with grey marble, and bears reliefs

illustrating Sir William Ramsay's numerous decorations and honours.

AN influential committee, with Sir F. G. Kenyon as its chairman, has issued an appeal for the foundation of a school of archæology at Jerusalem to conduct exploration in Palestine, Syria, and Mesopotamia. The school will facilitate the work of scholars, train students, excavators, and administrators, and assist in every way the Palestine Exploration Fund. Its researches will extend from the Stone age and the early cultures down to the later Mohammedan period. The school will catalogue existing remains and cooperate with the archæological departments which, it is hoped, the new Governments will establish. It will hold itself aloof from politics and religious controversies. A site has been secured for the necessary buildings at Jerusalem, and Prof. J. Garstang, of the University of Liverpool, who has already visited Palestine, has been provisionally appointed the first director. The scheme is in every way commendable, and the necessary funds will doubtless be provided without difficulty. Communications should be addressed to the Secretary, British School, c/o Palestine Exploration Fund, 2 Hinde Street, Manchester Square, W.1.

A DOZEN years ago the expressions "newer physics" and "newer chemistry" would have been taken to refer to those branches of the subjects which centred round the words "electron" and "radium" as opposed to those dealing with surface tension, sound, etc., or with atomic weights and constitutional formulæ to which the term "older" might have been applied. It is interesting to note how the last few years have rendered the two terms inappropriate, and how fields which were considered worked out, or at least not likely to produce returns which would justify the time spent on further research, have proved themselves not merely fertile, but also worthy of cultivation for many years to come. A revision of astronomy and physics in the light of the theory of relativity has to be carried out; the hydrophone has brought new problems in elasticity to light; we want more knowledge of atomic weights, of the action of catalysts, and of the synthesis of nitrates. On surface tension and contact angles a whole industry has been founded, some of the problems of which are dealt with by Mr. H. L. Sulman in a paper read before the Institution of Mining and Metallurgy on "Flotation," a summary of which appears elsewhere in this issue.

THE foundation of the Salters' Institute of Industrial Chemistry about a year ago was celebrated on December 11 by a dinner given by the Salters' Company to a number of leading representatives of applied chemistry, the Master, Mr. W. B. M. Bird, presiding. Salters or drysalters have for centuries been the recognised dealers in potashes, dyestuffs, and almost every chemical preparation; and their livery of the City of London has taken a prominent part in the promotion of technical education and of research in chemistry. The Company does this because, as Mr. Bird remarked at the dinner, it believes in the progress of chemical industry through scientific knowledge, and considers it a privilege as well as a duty to assist in such development. The institute established last year is not a building or a laboratory, but a foundation for the award of fellowships to enable post-graduate students to continue their studies, or suitably equipped chemists to carry on research in chemical industry. Grants are also made to artisans attending evening classes for the purchase of books and like assistance in their studies. The director of the institute is Dr. M. O. Forster, and under his capable and sympathetic guidance, with the liberal support of the Salters' Company, the fellowships, which are of the value of 250*l.* a year, promise to exert the same effective influence upon chemical science that the 1851 Exhibitions have upon scientific research generally. The scheme was wisely conceived, and its formation gives worthy cause of congratulation to all who are concerned with it.

THE appointment of Mr. G. H. Hardy, fellow and mathematical lecturer of Trinity College, Cambridge, to the Savilian professorship of geometry at Oxford reminds us that the present year marks the tercentenary of the foundation by Sir Henry Savile of the first university chairs of geometry and astronomy in Great Britain. Gresham in 1596 had inaugurated similar professorships in London, but the Gresham College never attained the importance it might have done, and London had to wait two centuries for her university. Both the famous Elizabethans, Gresham and Savile, performed valuable services for their Queen and country, and both were favourites at Court. Savile, who was born near Halifax, Yorkshire, in 1549, was, from 1585 until his death in 1622, Warden of Merton College, Oxford, of which he had been made a fellow in 1570. He founded the Savilian professorships in 1619, and the first holders of them were Briggs and Bainbridge, the former of whom had been the first Gresham professor of geometry. Briggs, who, like Savile, was born near Halifax, is best known for his notable works on logarithms and his intimacy with Napier, and the details of his life are generally familiar. Bainbridge did not rise to the same celebrity as his colleague, which may be partly accounted for by the fact that he was trained as a physician, and while Savilian professor of astronomy he was also Linacre reader in medicine. He was born in Leicestershire in 1582, and died in 1643, twelve years after Briggs. Savile, besides being Warden of Merton, was from 1596 Provost of Eton, where he died and is buried. He is commemorated by a monument in the choir of Merton College, close beneath which are the tombs of Briggs and Bainbridge, the former of whom died in the college, and the latter in a house just opposite.

MR. C. T. WHITMELL, the well-known amateur astronomer, who died at Leeds on December 10 after a brief illness, graduated at Cambridge in 1872, being placed in the First Class in the Natural Sciences Tripos and Senior Optime in the Mathematical Tripos. He was a prominent member of the British Astronomical Association, and contributed very largely to its journal. His interests lay in the mathematical rather than in the observational side of astronomy, though his long series of observations of the phenomenon known as the "green flash" are almost unique. Mr. Whitmell acted as director of the expedition to Spain organised by the British Astronomical Association for the purpose of viewing the solar eclipse in May, 1900. He was a fellow of the Royal Astronomical Society and published several papers in the Monthly Notices. His careful determination of the maximum duration of totality of a solar eclipse supersedes De Sejour's erroneous value. On his appointment as H.M. Inspector of Schools in Leeds in 1897 he identified himself with many of the scientific societies in that city. The Leeds Astronomical Society, which owes much to his interest and devotion, elected him as president in 1898–99. In his earlier years Mr. Whitmell did a fair amount of geological fieldwork, both in England and abroad. He was an active member of the Leeds Geological Association, of which he was at one time president.

A NOTABLE figure in the engineering world passed away on December 14 in the person of Sir John Jackson. Born in 1851, Sir John was destined to become

one of the most potent agencies of his day in directing the forces of Nature and adapting them to the service of man. As a contractor for large public works, he was responsible for the carrying out of gigantic engineering schemes, which have appreciably altered the topography of many lands, and remain a permanent record for the admiration of future generations. His most notable achievements include the great railway across the Andes from Arica to La Paz, the Hindiat barrage across the Euphrates near Babylon, harbours at Singapore and Simon's Bay, the Keyham docks at Devonport, irrigation works in Mesopotamia, the foundations of the Tower Bridge, London, and the last section of the Manchester Ship Canal. Sir John took a prominent part in political life, being M.P. for Devonport from 1910 to 1918. He was a member of the Royal Commission appointed to inquire into the South African War. Another Royal Commission recently exonerated his firm from the charge brought by the Public Accounts Committee that it had unfairly secured contracts which were not thrown open to competition. Sir John was knighted in 1895, and created a C.V.O. in 1911. Educated at York and Edinburgh University, the degree of LL.D. was conferred upon him by the latter. He was also a fellow of the Royal Society of Edinburgh.

A CONFERENCE of research associations—the second of a series—organised by the Department of Scientific and Industrial Research, was held on December 12 in the lecture-theatre of the Institution of Civil Engineers. The Right Hon. A. J. Balfour, Lord President of the Council, appropriately presided, the Department of Scientific and Industrial Research being a Committee of the Privy Council. Mr. Balfour, who was warmly greeted on his first public appearance in his capacity of head of the Department, delivered a short introductory address on the national need for scientific research, especially in its application to industry. Three points emphasised by Mr. Balfour were that, though man does not live by bread alone, the amelioration of the material lot of mankind can come only through progress in scientific knowledge; that we must not imitate, but follow the example of the Germans in realising a helpful and close alliance between science and industry; and that, in the prosecution of this aim, the paramount interests of pure science must not be overlooked. Papers were afterwards read by Major H. J. W. Bliss, director of the British Research Association for the Woollen and Worsted Industries, on "Research Associations and Consulting Work and the Collection and Indexing of Information," and by Dr. W. Lawrence Balls on "The Equipment of Research Laboratories." There was a general discussion on the subject-matter of the two papers, from which it was clear that, although there is a large common measure of agreement among the different associations, there is also enough variety of circumstance and character to make it desirable for each association to work out its own salvation in many problems of organisation and method. It is the intention of the Department of Scientific and Industrial Research to continue periodically these conferences of research associations. As the Department, in fostering the associations, is engaged in a novel adventure in Government enterprise, the research associations have to set sail on uncharted seas, without maps or precedent experience to guide them, and these periodical conferences must be of great help to them in mapping out their courses and taking their soundings.

THE important question of the future of wheat production, with special reference to the Empire, is dealt with at length in the current number of the Bulletin of the Imperial Institute. The annual production of wheat in the world prior to the war amounted to about 110,000,000 tons, the largest producers being the Russian Empire, with an output of 22,000,000 tons, and the United States, which provided nearly 19,000,000 tons. During the war the production in Europe as a whole, and in Russia in particular, decreased considerably, but outside Europe there was a great expansion. The acreage under wheat in Canada, the United States, Argentina, India, and Australia in 1918 was more than 25 per cent. larger than the average acreage for the five years before the war, and it is considered that at the present time there is a sufficiency of wheat, even without the help of Russia, to meet the requirements of the world. As regards the future also there is reason for optimism. There are vast areas of land suitable for wheat-growing yet to be opened up in Canada, Australia, South America, Siberia, and other countries, whilst the present low average yield of thirteen bushels per acre is susceptible of great improvement. In recent years the increase in the world's production has been due to a great extent to an increased yield per acre, and there is every reason to believe that with the introduction of improved drought- and rust-resistant varieties the rise will be even more rapid in the future.

IN the current number of *Parasitology* (vol. xi., Nos. 3 and 4) Dr. D. Keilin describes the larval structure and the complete life-history of a species of fly, *Melinda cognata*, Meig., the larvæ of which live as parasites in the snail, *Helicella virgata*, and he gives a short account of various other dipterous larvæ that have been found in living or dead snails and other molluscs. But the most generally interesting part of his paper is, perhaps, the additional note relating to snails and house-fly larvæ, to which Dr. C. J. Gahan has directed attention in a letter to the *Times*. For if the observations made by M. E. Séguy, which are now for the first time made known, turn out to be correct, as they probably will, a solution of the mystery surrounding the hibernation of the house-fly cannot be far distant. That from nine out of fifty snails collected in midwinter larvæ of *Musca domestica* were obtained may be an unexpected, but is not at all an incredible, statement. If true, the fact would at once go far to explain why the search in winter for larvæ or living pupæ of house-flies in or near the places in which they are usually to be found in summer has hitherto always met with failure; for no evidence has ever been obtained to show that house-flies go through the winter in the adult stage, and they must go through it somehow. The larvæ of some flies are known to live only in one species of mollusc, but there is no reason to think that this will be found true of the house-fly. Those who may search for its larvæ this winter would do well not to confine their attention to one or two common species of snail only; and should they look out also for its pupæ they may find them, not inside the body of the snail, as has been absurdly suggested, but in the earth near by, or in the sheltered hole in the wall where the snail itself is found.

A HIGHLY interesting paper on "The Direct Replacement of Glycerol in Fats by Higher Polyhydric Alcohols" is contributed to the *Biochemical Journal* for November by Prof. A. Lapworth and Mr. L. K. Pearson. The work described is the outcome of an endeavour to convert the large quantities of fatty acids produced during the war in the manufacture of glycerol into an edible foodstuff. These authors found that when olein or stearin is distilled under reduced pressure with mannitol in the presence of a little sodium ethoxide, almost the whole of the glycerol present in the original fatty compound is expelled, the

greatest yield being attained when the proportion of fat to mannitol corresponds with two molecules of the former to three of the latter. The other products of the reaction are chiefly water, a little alcohol, and a substance many properties of which are similar to those of the original fat. The composition of this latter substance corresponds with that of a mixture of the di-oleates (or distearates) of mannitan and isomannide.

THE first number of the *N.P.L. Review*, edited by members of the staff of the National Physical Laboratory, Teddington, appeared in November. Its thirty-six pages contain a large amount of information on the scientific and other activities of the staff, much of which will prove of interest to the general public as well as to those for whom it is primarily intended. Now that the laboratory is a Government institution, it seems reasonable that its work should be more widely known than it has been in the past, and readers of the review will find in it a clear statement of the way in which the laboratory has been fitted into the organisation of the Scientific and Industrial Research Department. From the articles on the old and new directors it appears that the process of fitting has necessitated a decrease in the responsibility of the office, and under Treasury regulations there seem now to be difficulties in the way of rewarding merit by increase of salary. Seven or eight pages are devoted to notes on the most important work passing through the various departments. All are interesting, and show clearly how the scientific problems of the industries are being solved. The staff of the laboratory is to be congratulated on its new publication.

THE power required for actuating the plant and machinery of the Panama Canal is obtained by utilising the flow of surplus water over the Gatun Dam, the height of which above sea-level enables an average effective head of 75 ft. to be realised throughout the year. The power plant at first installed comprised three turbines, each of a rated capacity of 2250 kilowatts when running at 250 revs. per minute and supplied with 500 cu. ft. of water per second. A flow of 500 cusecs, with a fall of 75 ft., produces nominally 3160 kilowatts, so that there is an efficiency margin of 37 per cent. The demand has been found to be much under-estimated, and it has become necessary not only to provide three additional machines of greater capacity, but also to increase the output of the existing generators. Of the three additional machines only one is yet in position, but when the installation is complete there will be three units of 2880 kw. each and three units of 4500 kw. each, totalling 22,140 kw., and requiring a supply of just over 4000 cu. ft. of water per second. The electric energy is employed to drive the machinery of the locks at Gatun, Miraflores, and Pedro Miguel, of the haulage locomotives, of the permanent machine-shops, of the dry dock, and of the coal-handling plant, besides lighting the locks and many towns comprised within the canal zone—a stretch of country ten miles in width across the isthmus. We are indebted for the foregoing particulars to an article in the *Engineer* of December 5.

MR. E. A. MARTIN, the author of "Dew-Ponds," is bringing out through *Messrs. Allen and Donaldson, Ltd.*, 57 Marsham Street, S.W.1, a book entitled "Life in a Sussex Windmill," recounting his experiences of three years in a somewhat unusual dwelling, and giving particulars of his observations of Nature on the Sussex Downs. The portions of the book which will be of special interest to readers of NATURE are the chapters devoted to the geology of the Downs, the problem of the dry combes, prehistoric man and marling, water-supply, fossil oysters, Sussex iron and wood, and the possible discovery of coal in the county.

THE *Cambridge University Press* has in preparation "The Cambridge Ancient History," the general plan of which will be similar to that of the Cambridge Modern and Medieval Histories. It will be in eight volumes, and, beginning with an account of archæological discovery, will trace the history of Egypt and Babylonia, Assyria and Persia, Greece and Rome, to 324 A.D. The work will be edited by Prof. J. B. Bury and Messrs. S. A. Cook and F. E Adcock.

OUR ASTRONOMICAL COLUMN.

THE DECEMBER METEORIC SHOWER.—Mr. Denning writes that this display was well observed at Bristol on the night following December 13. The early evening was overcast, but after a storm of rain at 10 p.m. the sky cleared, and between 10h. 30m. and midnight meteors were observed to be falling at the rate of thirty-five per hour. The moon rose just before 12h., and during the next hour, when her light and films of thin cloud obscured some of the smaller meteors, the horary rate decreased to seventeen. There were two radiants, viz. at 114°+33½° (eighteen meteors) and at 107°+24° (twelve meteors), but the marked differences in aspect of the members of the two streams were very pronounced. The first-named radiant represented the true Geminids, and they are of moderate speed, with short paths sometimes stellar in aspect, and of a sparkling silvery-white colour.

A brilliant Geminid was seen at 11h. 40m. falling from 131°+10° to 138°+0°, and giving a succession of flashes. It lit up the foggy, humid atmosphere, and was much brighter than Jupiter, slightly to the east of it. This meteor must have been a splendid object as seen from the Eastern Counties of England, and it is hoped that further observations will come to hand. A very conspicuous lunar halo was visible during the early morning hours of December 14.

DISCUSSION ON RELATIVITY.—The meeting of the Royal Astronomical Society on December 12 was entirely devoted to the consideration of the theory of relativity. The discussion was opened by Prof. Eddington, who said that while on the first relativity theory time was adopted as the fourth co-ordinate merely as a convenient system, in Einstein's theory the time-space continuum was inextricably blended, so that what was pure time to one observer was resolved into partly time, partly space for another, differently circumstanced. The distinction between past and future was, however, for sentient beings somewhat greater than that between right and left. If space were re-entrant and finite, the section of the continuum in the time direction would be hyperbolic, so that time would not repeat itself after an enormous interval.

Dr. Jeans said that physicists had other than astronomical grounds for asserting that the foundation-stone of the new system was "well and truly laid." It was originally built on experiments, and since its enunciation further experiments had confirmed its truth. He gave the expressions for a wave-front of light, stating that an observer initially at its source remained central in spite of his own movement.

Sir Oliver Lodge referred to some of the apparent paradoxes that had been uttered, and said he preferred to take the æther, not the observer, as his base of reference, instancing the confused idea of the landscape that one obtained when travelling by train.

Dr. Silberstein pointed out that the star displace-

ments on the plates were not exactly radial, which he took to mean that they were not due to gravity, but to some irregular refracting medium. He further said that Einstein himself regarded the shift of the solar spectral lines as vital to his theory.

Prof. Lindemann and Dr. Jeffreys agreed in thinking that the experiments were by no means decisive against the existence of the spectral shift. The latter further stated that a medium capable of producing the observed shift of the stars by refraction would reflect a great deal of sunlight, whereas the plates showed no trace of such matter near κ Tauri.

FLOTATION PRINCIPLES OF ORE EXTRACTION.

AT the meeting of the Institution of Mining and Metallurgy, held on November 20, a paper entitled "A Contribution to the Study of Flotation" was presented by Mr. H. Livingstone Sulman. After giving a brief historical review of the development of flotation as applied to ore extraction, with the problems that arose in connection with successive phases of the process, Mr. Sulman dealt principally with froth flotation, which he characterised as the final link in a long chain of effort. The essentials of this process are that an aqueous pulp shall be agitated with certain reagents which may be classified as a "froth-producing" material, a "froth-stabilising" substance, and a "gangue-modifying" addition.

The explanation of flotation may be based on the differences shown by various substances in the degree to which they are "wetted" by water and other liquids. "Wetting" is a condition of wide variability, and a theory of flotation must be based largely upon the physics of wetting. The degree of wetting may be influenced by the molecular porosity of the solid surface, and indicated more or less quantitatively by the "contact angle" made between the free surface of the liquid and that of its interface with the solid.

Reviewing the various problems encountered in dealing with flotation, Mr. Sulman devoted considerable attention to the molecular constitution of liquids and solids, gravitation and molecular forces, surface energy and surface tension, interfacial tension which involves consideration of the effects of complete wetting and differential wetting, hysteresis, adsorption, the *rôle* played by immiscible oil, and the action of modifying agents such as acids. In this last connection the theories of flocculation and deflocculation have to be taken into account, including their electrical relationship. Film flotation and differential flotation receive separate attention.

The general summary of the paper gives prominence to the following findings:—Flotation reactions result from the molecular forces acting at the surfaces of solids and liquids; these arise from unbalanced molecular attractions in the surface layers, which in turn are in functional relation to the balanced molecular attractions constituting cohesion for a solid or a liquid. Every solid or liquid, therefore, possesses excess energy at its surface, which may be exhibited in adhesion effects. Liquid-solid adhesion is broadly reciprocal to interfacial tension. The degree of wetting can be relatively quantified within certain limits by the contact angle made between the free surface of the liquid and that of the solid. Contact angles have a minimum and a maximum value; the angular difference between these values is the hysteresis of the contact angle, which permits a wider range of equilibrium for a floating particle.

The dynamical aspect of the subject is concerned with the molecular constitution of the interfaces, with the kinetic effects of molecular motion at the surfaces and interfaces of solids and liquids, and with those in the interior of liquids. Solid surfaces are probably penetrable by the molecules of liquids, which enhances the adhesions between them; such penetrations may give rise to a persistent tendency for the solid to be again wetted by the same liquid. Concentration of foreign molecules at the surface of a pure or homogeneous liquid (positive adsorption) reduces the surface tension of the liquid and confers upon it the property of "frothing."

Frothing reagents useful in flotation produce a froth with water, yet leave a partial strain (mineral-adsorptive energy) at the bubble surface. The mineral adsorption now stabilises the film, especially if the mineral be minutely oil-filmed; still more so if flocculated. To be employed effectively the bubble system must be disseminated throughout the mass of ore-pulp. When water-strain is completely removed from the surface of suspended particles, deflocculation results. Flocculation is greatly increased by mechanical agitation, by minutely oiling the particles, and by contact with air; these are factors necessary to produce standard mineralised froths. Generally, if a substance can be flocculated it can be floated. Electrical phenomena are concomitants of minor order. Flotation depends on bringing about the most advantageous selective adhesions, selective adsorptions, and selective flocculations between the complex of particles in an ore-pulp.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS (ABRIDGED) BY SIR NAPIER SHAW, LL.D., SC.D., F.R.S., PRESIDENT OF THE SECTION.

Educational Ideals and the Ancient Universities.

A PRESIDENTIAL address before the Educational Section of the British Association is an undertaking that might fairly daunt the bravest of those who are really acquainted with its difficulties. The vast range and variety of the problems of education; the enormous amount of effort that is already expended upon them; the torrents of advice and criticism that are offered by those who are familiar with the details of the various curricula, who know how things ought to be done—if I had had time and capacity to become acquainted with all these things, I suppose I must have avoided the duty of making an address. It is, perhaps, the detachment of my present position from any responsibility for details which gives me the courage to recall experiences, now twenty years old, acquired during a lengthy service in various capacities at Cambridge, and matured by twenty years of the consciousness of the dire need of educational discipline and training for those whose business it is to use science in the service of the State.

With a certain amount of assurance I can even be glad that I am not in touch with the educational controversies of the hour, and confidently trust that my deficiencies will be made good by the contributions of those who know to the discussions which will take place in the Section, but the difficulty that I cannot get over just now is that, from the unavoidable circumstances of the present time, a presidential address is a "back number" before it is delivered, for the simple reason that, according to tradition, it must be printed in advance. In this particular year there is an almost immeasurable gulf of experience between the time of my appointment in 1917 and the delivery of this

address; the president himself is in many ways a different person from him who undertook the duty of addressing you two years and a half ago.

At that time I had been a good deal moved by the wearying controversy about the relative merits of classics and science in education, because the physical sciences as taught were such a doleful misrepresentation of the spirit of inquiry about the universe which has moved men in all ages and is as clamant to-day as ever. The mysteries of the firmament, the midnight sky, the storm and calm, the earthquake and the thunder, the sunshine, the rainbow and the halo, the intolerable heat and the pitiless cold, the mariner's compass, the aurora and the mirage, are still as wonderful as ever to the wayfarer and the seafarer, and even the dweller in towns wants to know more about them. Yet our educational system, as I knew it, passed all these subjects by and offered instead the determination of the specific heat of copper, with other things that the specific heat of copper stands for. The same, I believe, is true for many of the most interesting subjects of scholarship in ancient and modern civilisations, learning, and languages. And if an inquirer, young or old, should ask whether, if he went there, the great universities could tell him all about the things of wonder or of beauty that he is conscious of, or about the reminiscences of past generations that he finds around him as he travels through life, he could only be told that in consequence of the perverse malignity of external circumstances they had no money to devote to his enlightenment. The capacity would be there in abundance, but not the means. In three years they would put him in a position to pursue intelligently for himself if he pleased any of the subjects in which his interest had been excited, but the facilities for education would extend only to the point where his interest began.

So I wrote a little pamphlet on "The Lack of Science in Education, with Some Hints of What Might Be," and when I was invited to occupy this chair I thought I might be of some service to education if I pressed the subject further and endeavoured to show how, in spite of the good will of nearly everybody concerned, the peculiar constitution of our chief universities was really standing in the way of the lofty ideal of higher education which must find expression if the education which we all want is really to come to pass in this country.

Circumstances have already vastly changed. Committees have sat upon the teaching of science and the teaching of modern languages. A great Education Act has been passed, and the poverty of the universities has overstepped the limits of starvation and a Commission of Inquiry is promised. So we are now on the high road to making presidential addresses matters of quite subordinate interest. Still, you may be interested to hear what I wrote two years and a half ago in explanation of the peculiar difficulties of our educational system; so here it is. It makes a good deal of play of a certain scene in "The Merchant of Venice," which I shall beg you to regard, for a few minutes only, as a satire upon the state of the universities in the spacious times of Queen Elizabeth, after a period of magnificent activity on the part of founders and benefactors and after a succession of statutes for the universities made by successive monarchs for the governance of those institutions, which were then recognised as of the highest importance in the State. Such a period of reconstruction seems to have come again in our time, and the satire, if it be one, is as true to-day as it was three centuries ago.

I was arrested by the curious sentiment, "If to do were as easy as to know what were good to do, chapels had been churches and poor men's cottages princes' palaces." I wondered whether Portia was in fact intended to personify a liberal education. For other subjects of human activity her statement is palpably absurd. All the experience of the British race indicates to us that the acute divisions between people arise in discussions as to what were good to do; the actual doing is easy if the preliminary question "what were good to do" is really decided. Can anyone doubt that after our experience of the war?

But if it were education that Shakespeare was thinking about, chapels and churches, poor men's cottages and princes' palaces are not inappropriate in that connection; the sentiment stimulates the imagination. Certainly in education to know what were good to do does seem in practice to be infinitely easier than to do. From time to time the newspapers are full of reports of conferences, meetings, congresses, and assemblies all fully assured that they know what were good to do, yet very little happens. Our scheme of education is still unsatisfying. Why?

That is the question which I propose for your consideration. Why is it that all the pious opinions about education come to nothing or to so little?

First of all it must be noted that the resolutions and proposals are not addressed to anybody in particular. Presumably they are intended to form public opinion, but public opinion has no authoritative voice with those who are in charge of the higher educational institutions. The resolutions are sent out like wireless signals from a ship at sea. Any educational institution with a receiver tuned to the proper wavelength can take them in, but if the receiver is not tuned or the operator is inattentive, nothing happens. There is no corporate responsibility for the aggregate of our higher educational institutions.

We may, I think, agree that if we wish for ideals in education in this country we must find them in the universities. If the universities give the encouragement of their example and their licence to teach only to men and women who are really educated in the best sense of the word, their influence will leaven the whole of education throughout the country; and, on the contrary, if when they leave the universities the men and women who have to teach, or to control teachers, are themselves imperfectly educated, it is hopeless to expect a well-balanced, living educational system. Among the universities, for reasons good or ill, into which I need not enter, the older Universities of Cambridge and Oxford have a preponderant influence.

And, to my mind, the outstanding characteristic of the organisation of the older universities is the lack of any recognised door by which their corporate responsibility can be reached. In each case the university is itself a corporate educational institution which includes some twenty colleges, which are also separate corporate educational institutions. You never can tell whether the persons with whom you have business are the university or the colleges, and it is quite possible that when you think to address the one you find yourself confronted with the other. The universities in their corporate capacity are constrained by statutes and traditions handed down by our forefathers to look on in comparative impotence while their ideals are distorted or concealed by the interplay of the interests of the many corporations of which they are composed. The whole complex scheme of management forms a sort of craft or mystery which very few even of the initiated really comprehend.

In January of 1917 the Headmasters' Conference (which consists of men with some academic experience) passed a resolution to the effect that Greek should no longer be required for the entrance examination of the Universities of Oxford and Cam-

bridge, and thereupon the Master of University College, Oxford, spent half a column of the *Times* in explaining that the University of Oxford had no entrance examination at all.

This veil of mystery about matters of national concern is very perplexing for those who want things done in education, but do not know the technicalities of the universities. What is true, for Cambridge at least, is that the university *qua* university has no examination for entrance; it is obliged by its statutes to accept as a member without any question anyone presented by the recognised authority of a college, regardless altogether of his qualification or disqualification for a university career. It is a very remarkable arrangement. The university makes no inquiry as to a student's fitness to profit by its educational system; it leaves all that to the colleges, and many, if not all, of the colleges have an entrance examination. So I offer this paradox for the logician who is interested in higher education.

The university consists of the members of its constituent colleges and a few others. At the discretion of the several colleges, or the non-collegiate students' board, 75 per cent. of the members of the university are required to pass an entrance examination before they are accepted for presentation to the university for matriculation. There are at least four examinations of the university which are accepted by colleges on occasions in lieu of their own entrance examinations. Yet there is no entrance examination for the university.

And this does not end the matter. With the power of selecting its students vested in twenty different bodies, the university becomes a controlling body rather than an educational institution with a definite purpose and programme. The regulations for its students are nearly all of them of a negative character. The discipline and the regimen of the university rest upon the assumption that a student desires to secure from the university not so much attainment as a stamp for his attainments. A member of the university cannot be admitted to a degree unless he has satisfied certain conditions of residence, and also satisfies certain examiners; his name is not accepted for the final examination unless he has satisfied certain other examiners. There is nothing in the regulations or administration of the university to secure that a matriculated student shall study or aspire to take a degree. He might live on in idleness and ignorance for the rest of his natural life; the university has no choice in the matter so long as his college pays the periodical fees. It trusts to the colleges to see that idle or unsuitable undergraduates are invited to go elsewhere.

Here we have one of the many instances of the division of jurisdiction between the colleges and the university which hides the ideals of our system of higher education in an impenetrable fog.

The university is governed by the colleges according to a system which goes back to the time when "The Merchant of Venice" was written, so let us revert to the conversation between Portia and Nerissa which expounds the lottery of the caskets in the well-known scene. The position of the university in the matter of the selection or rejection of its members is exactly that which Portia bewailed to Nerissa. Let me invite you to regard the episode of the caskets as a figurative representation of the lottery by which the University of Cambridge selects those upon whom she bestows her inherited riches—*lucem et pocula sacra*. Cambridge, like Portia, the heiress of all the learning of the good and the great, bound by the fantasy of her ancestral tradition never to choose for herself.

Let us think of Portia as the Vice-Chancellor of the University of Cambridge, desiring above all things the advancement of learning, and of Nerissa as a proctor, whose duty it is, as representing the Senate, the collective body of members of the colleges, to see that the statutes and ordinances are duly attended to. Listen to the conversation:—

"*Portia* [*V.-C.*]: O me, the word 'choose'! I may neither choose whom I would nor refuse whom I dislike; so is the will of a living daughter curbed by the will of a dead father. Is it not hard, Nerissa, that I cannot choose one nor refuse none?

"*Nerissa* [*Proctor*]: Your father was ever virtuous; and holy men at their death have good inspirations; therefore the lottery that he hath devised in these three chests of gold, silver, and lead, whereof who chooses his meaning chooses you, will, no doubt, never be chosen by any rightly but one who shall rightly love. . . .

"*Portia* [*V.-C.*]: If I live to be as old as Sibylla, I will die as chaste as Diana, unless I be obtained by the manner of my father's will."

I need scarcely say that I should not spend so much time over what may seem to many of you far-fetched, and perhaps unseemly jesting, if I did not believe that this fantastic view of the lottery of the caskets contains the suggestion of an element in the governance of our highest educational institutions which deserves your gravest and most serious consideration. What I have in mind at the moment is the unforeseen and undesired result of the competition of the colleges within the university itself as quasi-independent educational institutions. It is this small matter, from some points of view of quite minor importance, which, so far as I can see, prevents our great universities from taking the leading part which they might take in exemplifying the ideals of a co-ordinated national system of education, and makes the success or failure of those great institutions something of the nature of a lottery. They may offer ten thousand different avenues from matriculation to a degree, and yet the student may find himself imperfectly educated in the end.

One may, indeed one must, picture to oneself the idea of the colleges as a number of educational institutions co-operating in an avowed and transparent common purpose of the university to display the highest educational ideals. So I think, if they were willing, they might be, without any sacrifice of their individuality or of those magnificent traditions which have fulfilled the high purpose of their pious founders and benefactors. Let us keep that picture for a while in mind.

I have taken from the Cambridge University Calendar for 1918 a list of subjects selected for teaching in the university and colleges, with the number of professors, readers, lecturers, or teachers assigned to the several subjects.

I find that there are 175 university teachers (professors, readers, lecturers, etc.) and 176 college lecturers. I find that the 175 university teachers between them deal with 72 subjects, an average of 2¾ per subject, and are distributed between subjects in the following manner:—

Number of university teachers assigned for a subject

9 8 7 6 5 4 3 2 1

Number of subjects which have the number of teachers specified in the upper line

2 3 1 4 1 3 8 10 42

The 176 college lecturers deal with only 23 subjects, an average of 7½ per subject. They are distributed as follows:—

Number of college lecturers assigned for a subject
33 30 23 18 17 10 5 3 2 1 ?
Number of subjects that have the number of teachers specified in the upper line
1 1 1 1 1 1 3 1 3 9 6

Here we see at once a great difference between the educational systems. The university is obviously striving to meet so far as possible its higher educational responsibilities. There is great differentiation of duty; 42 teachers are responsible each for a single subject; there are only two cases in which a subject has so many as nine teachers, whereas in the colleges the tendency is for the same subject to have a great number of exponents. The favoured subjects are:—Classics 33, mathematics and natural philosophy 30, history and economics 23, natural sciences 18, and divinity 17. All those subjects are also provided for, to some extent at least, in the programme of the university. There may be, and indeed must be, some differentiation within these totals, but it is a differentiation which the college authorities do not think it necessary to disclose. Whatever allowance may be made for that, I think it is obvious that the colleges tend to repeat many times over a stereotyped form, and not to distribute their energies over subjects which, for lack of funds or some other reason, are not represented in the university list. Three subjects appear in the college list and not in the university list, namely, modern Greek, Celtic, and military history. We may be sure that the 176 college lecturers are in themselves fully competent to represent subjects of profound human interest which the university disregards for want of means. That it is the system and not the lecturers that account for this convergence upon a few subjects was evident enough during the war, when Cambridge lecturers were to be found among the most proficient and successful workers with their brains in many departments of activity. The needs of peace are not less urgent than the needs of war.

No one can think that the distribution of teachers and subjects would be what it is if the educational system of the university and the colleges were under the control of a single competent body bent upon manifesting a true ideal of the use of educational endowments, whether in money or men.

Suppose, for example, that the council of the Senate were recognised as responsible to the country for the educational system of the university and the colleges jointly; that, once appointed, they were freed from the referendum of every item of their procedure to the lottery of a vote in the Senate. Imagine what would happen if the university really had an entrance examination and the colleges had to select their members from among the successful candidates. One may speculate upon what such a body would produce, but it is scarcely imaginable that they would plump for concentrating so much of the college teaching in general terms upon classics, mathematics, history, and divinity.

And, in support of the contention that diversity of intellectual effort is a pertinent consideration, I would point out that if recondite subjects are to be studied at all it must be at our own great centres of learning. If there is any part of the world where old customs are dying out, or interesting species becoming rare or extinct, it is for highly centralised countries like ours, at a distance from the scene of action, to take care that the subject is studied while there is yet time. On the spot, where no doubt the material is more readily available, people are too much preoccupied to notice the ultimate effect of their own personal activity. If we should, for example, set about exterminating the vermin of London houses (which, by the way, is above all things a most urgent question of re-housing), it is not from any Londoner, or even from our near neighbours in Cambridge, however interesting the minor horrors of war may be to their biologists, that any protest will be raised about the outrage which the extermination would entail upon the province of natural history.

I have looked through that interesting volume "The Yearbook of the Universities of the Empire, 1914," to see whether the older universities of this country and the Empire had a notably extended or different range of subjects. The differences are mostly in name or in the differentiation of medical and theological subjects. It is interesting to note the gradual formation of university teaching in new lands. It seems to begin with medicine and theology, law, engineering, architecture, commerce, and banking; and next to take in our old college friends mathematics, classics, and natural sciences, but it seldom shows any particular characteristics of local scholarship or specialised learning; in the older institutions there are some suggestive subjects, as Assyrian and Babylonian archæology, classical archæology, African languages (Swahili and Bantu), Irish language and literature, Dutch language and literature, Japanese, Portuguese, Scandinavian languages and Thibetan, phonetics, library science, ancient Indian history and culture, Colonial history, Irish history, Scots history, civic design and civic law, scholastic philosophy, Zend philosophy, rhetoric and oratory, geodesics, acoustics, meteorology, and epidemiology in various forms.

Among the subjects which I have noticed in other connections as not represented by name in any of the universities of the Empire, but still claiming attention from those who would help to make the facilities for education complete, there are, in the first place, the history of the various arts and sciences and of medicine, for which some provision has recently been made at Oxford under Dr. Singer; oceanography, which, through the generosity of Prof. Herdman, has now obtained a footing in Liverpool; geodynamics, for which Cambridge wishes to make provision, historical geography and exploration; Malay and Polynesian languages and antiquities, aerodynamics, meteorological optics, now neglected in this country; terrestrial magnetism, seismology, climatology (past and present), particularly of the Empire; illumination and photography, metrology, the science of precision, British archæology and dialects; and perhaps the technical subjects of radio-telegraphy, ballistics, and ventilation. These are subjects with which alone a fully equipped university is competent adequately to deal, and the country is ill-provided until the educational authorities co-operate to supply between them what is needed. To secure this object I am not at all convinced that State aid is the only possibility. The pious benefactor is no more extinct than he was in the days of Henry VIII. and Queen Elizabeth, but while the universities and their colleges speak with two voices and leave us uncertain as to their ideals, it is impossible that he should not be discouraged.

As one passes in review our own educational institutions, one may judge of their ideals by their results. Judging in that way, and looking at the education of our public schools, we may fairly say that the social or ethical ideal is splendid. It expresses the principle of excellence which I take to mean success in fair competition. It is no doubt Hellenic rather than Christian; it is based upon the literature of the ancient Greeks, and has still strength enough to call forth the most devoted self-sacrifice. In the universities also the same ideal is quite easily recognised. There, if anywhere, you can see the worship of success in fair competition developed into a

real religion. For a long time I have thought that we should be much nearer understanding our real position in these things if we could persuade the classical scholars to do for Greek religion what the compilers and translators of the Bible did for the Hebrew—that is, to collect together in the best available translation the literature of the Greeks which formed the basis of their guides to conduct. The appropriate contents of such a collection were sketched out by Dr. James Adam, a college colleague of mine at Cambridge, whose untimely death is still deplored, in his Gifford lectures on the religion of the Greeks. With him the subject was a source of unbounded enthusiasm, and his lectures are a series of sermons on the Testament of the Greeks. But we ordinary readers, unlearned in the Greek literature, are in the position of those who are offered sermons on the Old Testament instead of the Old Testament itself. If you imagine where we should stand if the Old Testament were denied to us except in the original Hebrew, you will understand the position the vast majority of us must occupy with regard to Greek ethics, which are, in fact, the ethics of our ruling classes in the old sense. Therefore I use this opportunity to beg those who are enthusiastic for Hellenistic studies to give us such a Testament. I feel sure it will enable us to understand the ideals of the public schools and universities, and throw an entirely new light upon the supposed conflict of classical and scientific studies, which is possibly only another phase of the other perennial dispute about religious education.

The ethical ideals of our schools and universities are clear, excellent in themselves, and appreciated everywhere. They manifestly excite enthusiasm and develop the spirit of self-sacrifice for their maintenance. But what of the intellectual ideals? The subject is important, because the cultivation of the intellect is the avowed purpose of academic institutions, and the part of education which is necessary for carrying on the world's work. Looking at the actual practice of the universities, we can see that the intellectual ideals are obscured, confused, and enfeebled by the very process of competition between colleges which is so eminently successful in developing the ethical spirit.

But the opportunity for strengthening and clearing our intellectual ideals is now. It may require some sacrifice of prejudices and traditions as between colleges and the university, but the reward will certainly be great.

I suppose that the character of any distinguished educationist a century ago would be summed up in the words, "He spared not the rod"; and to-day perhaps the highest praise is expressed by saying that "He spared neither the ratepayer nor the taxpayer," but even that is not enough. Money without motive power does not make education. We may reserve our highest praise for those educational establishments of which it may be said that in the pursuit of a true ideal they spared "neither their prejudices nor their inherited privileges." It may sound sacrilegious, but it must be said: the Portia of our dreams will not become the *alma mater* that the nation needs if she can never be obtained except after the manner of her father's will.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SHEFFIELD.—Prof. C. H. Desch has been appointed professor of metallurgy in succession to Prof. J. O. Arnold. Since September, 1918, Prof. Desch has been professor of metallurgy in the Royal Technical College, Glasgow, and he was previously Graham Young lecturer in metallurgical chemistry in the University of Glasgow.

VISCOUNT HALDANE, as president of Birkbeck College, was in the chair at the founder's day celebration on December 12. Fifty-eight of the graduates of the college who have taken their degrees at the University of London since 1914, totalling 138, were presented to the president. The Principal (Dr. George Senter), in his report, said that 600 Birkbeck men were known to have been on active service. Of these 331 obtained commissions, and 87 names were on the roll of honour. During the war the chemistry department of the college provided certain drugs needed for war purposes, and the physics department tested more than two thousand optical instruments. Four-fifths of the students in normal times were evening students. Lord Haldane gave an address on "What is Truth?" He said this was a topic on which he had been reflecting for forty-five years—ever since he first entered a university. This question was bound up with another, the same thing in another form, the relativity of knowledge, of which we had heard a great deal just lately. Einstein had told them about it, but he had dealt only with a fragment of the problem of relativity, which covered the whole field of knowledge. The problem of relativity went far beyond the mathematics of astronomy. What was it that Einstein had been trying to tell the world? Even when you could put truth into a nutshell, it was not always possible to keep it there. The problem which Einstein had raised was not new. People had thought of time and space as something they knew all about, of a straight line as the shortest distance between two points. He then explained that to answer the question "What is Truth?" we must realise that the principle of relativity had shown us that the reality and our conception of it are not wholly separate. The observer and the observed could not be separated, and account must be taken of the observer. Sir Frederic Kenyon moved a vote of thanks, which was seconded by Mr. James C. N. White.

THE Manchester Municipal College of Technology is making an appeal to the industrial and commercial community of Manchester and of south-east Lancashire for the sum of 150,000*l*., with a view to the extension of the present building and equipment on land adjoining the college bought some years ago for that purpose at a cost of 44,000*l*. The present teaching resources of the college are taxed to overflowing with full-time day students, who now exceed five hundred, the majority of whom are proceeding to degrees in the faculty of technology in the University, whilst others are engaged in whole-time post-graduate scientific industrial research. There is every prospect that this number will be considerably augmented in the near future, and the governing body is desirous of making the fullest preparation for the increase, having regard to the serious competition of the chief foreign nations, notably America, Germany, Switzerland, and Japan, in the overseas markets. The urgent need for this extension has been commended by several important firms representative of the chief industries of the area, notably those engaged in the chemical, engineering, and textile trades; and at a recent meeting of the local branch of the Federation of British Industries held in the city the following resolution was unanimously passed:—"That, having regard to the fact that the Manchester College of Technology was the first technical institution of university rank to be established in this country, and being firmly of opinion that the development of the invaluable work of the College of Techno-

logy is of vital importance to the well-being of the industries of the district and county, the executive committee of the Manchester District Branch of the Federation of British Industries confidently commends the appeal for 150,000*l.* (of which 26,000*l.* has been promised absolutely and conditionally) to extend the College of Technology to the sympathetic consideration of all Lancashire producers, being of opinion that lack of whole-hearted support will be to the prejudice of Lancashire industry." This welcome change in the attitude of great industrial firms towards technical training and research leads to the hope that this appeal may meet with the cordial support which its serious and essential importance demands.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 4.—Sir J. J. Thomson, president, in the chair.—A. M. **Williams**: The adsorption of gases at low and moderate concentrations. Part i.: Deduction of the theoretical adsorption isostere and isotherm. Part ii.: Experimental verification of the form of the theoretical isosteres and isotherms.—A. M. **Williams**: The adsorption of gases at low and moderate concentrations. Part iii.: Experimental verification of the constant in the theoretical adsorption isostere.—T. R. **Merton**: The secondary spectrum of hydrogen. It has been found that the presence of a large quantity of helium in vacuum tubes containing hydrogen modifies the secondary hydrogen spectrum in the sense that the relative intensities of the lines are completely altered, some lines being extremely weak in the spectrum of the mixture, whilst others are greatly enhanced and a number of new lines appear. Measurements have been made of the lines which are enhanced or unaffected by the admixture of helium; the changes are shown in a reproduction of a photograph of the two spectra in juxtaposition with a wave-length scale, by means of which the lines which are weaker in the spectrum of the mixture can be identified by reference to Watson's measurements of the spectrum. The secondary hydrogen spectrum is of such complexity that the segregation of its lines into series of mathematically related lines is a task which offers great difficulties. These difficulties can doubtless be lessened by the aid of physical methods of separating the lines into different classes.—T. R. **Merton**: The spectra of isotopes. (1) Interferometer measurements of the principal line in the spectrum of ordinary lead and lead from pitchblende show that in the latter case the line is less refrangible by 0·0050 A. ± 0·0007 A., in close agreement with the results of Aronberg. (2) In the case of lead from Ceylon thorite it has been found that the line is more refrangible than in ordinary lead by 0·0022 A. ± 0·0008 A. (3) The positions of the lines are arranged in the order of their atomic weights. (4) Spectroscopic measurements seem to provide a favourable method of distinguishing isotopic elements. (5) A comparison has been made of the wave-lengths of the principal line in ordinary thallium and thallium from pitchblende residues. The wave-length of the line in the spectrum of thallium from pitchblende has been found to be more refrangible than the line in ordinary thallium by 0·0055 A. ± 0·0010 A. In the case of thallium the measurements may possibly be affected by certain disturbing factors which do not apply to the measurements of the lines of lead. Unless the results are affected by these disturbing factors, it would seem likely that the thallium in pitchblende is an isotope of ordinary thallium.—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. Part ii. It is shown that the catalytic action of metals, like that of certain enzymes, is reversible; in other words, compounds which are saturated in the ordinary sense are capable of interacting with the metal to form a system which breaks down into a more stable equilibrium consisting of hydrogen and a less saturated compound. This is readily demonstrated in the case of cyclohexanol; when a mixture of cyclohexanol and methyl cinnamate is heated at 180° in presence of nickel, a considerable transference into cyclohexanone and methyl β-phenyl propionate is effected. It is necessary that both components of the system should be present in the liquid state. Dehydrogenation has also been effected in the case of hexahydroxylene and dihydropinene mixed with methyl cinnamate in presence of nickel; in these cases a temperature of 230° is required. At this temperature small quantities of an ethyl oleate of unknown structure are obtained from ethyl stearate.—F. **Horton** and Ann C. **Davies**: An experimental determination of the critical electron velocities for the production of radiation and ionisation on collision with argon atoms. The critical velocities for electrons in argon were investigated by methods similar to those employed in a previous research for the determination of the corresponding values in helium, the earlier form of apparatus being modified somewhat to facilitate the detection of the beginnings of radiation and ionisation. As the result of many experiments under different conditions, the values 11·5 volts and 15·1 volts were obtained for minimum radiation velocity and minimum ionisation velocity respectively. No sudden increase of radiation at the second critical velocity was detected, and it was shown that no detectable amount of ionisation was produced at 11·5 volts. The limiting wave-length of the argon spectrum, calculated from the value, 15·1 volts, found for the minimum ionisation velocity, is in agreement with the limit observed spectroscopically in the recent experiments of Lyman.

Royal Microscopical Society, November 19.—Mr. J. E. Barnard, president, in the chair.—H. M. **Carleton**: Note on the Cajal formalin-silver nitrate impregnation method for the Golgi apparatus. The theory of silver impregnation in general was briefly outlined and the technique of the Cajal method described. Mention was made of the impregnation of cell-constituents other than the Golgi reticulum, while the problem of the production of artefacts by the various methods used for demonstrating the Golgi apparatus was discussed. Finally, mention was made of the various changes undergone by the Golgi apparatus during certain physiological processes, *i.e.* glandular secretion, intracellular fat formation, ossifraction, etc.—F. I. G. **Rawlins**: Report on the collection of metallurgical specimens recently presented by Sir Robert Hadfield, Bart. In 1918 a suggestion was made that the society might further interest, and perhaps research, in metallography. To this end Sir Robert Hadfield presented the society with a collection of specimens. These were polished at the Royal School of Mines by permission of Prof. Carpenter, and it is intended that they shall be available for microscopic examination by fellows, in much the same way as the general collection. A catalogue is being prepared, which will be ready shortly, giving brief details of the microstructures, etc.

Linnean Society, November 20.—Dr. A. Smith Woodward, president, in the chair.—Dr. G. C. **Druce**: The occurrence in Britain as native plants of *Ajuga genevensis* and *Centaurium scilloides*, Druce, var. *portense* (Brot.). Although there are previous records of *Ajuga genevensis* from Britain, the records are probably mistakes for *pyramidalis* or other species, and in one instance due to a garden-escape of the true plant.

This discovery of *genevensis* on the Berkshire downs is an undoubted evidence of it as a British species. *Centaurium scilloides* is the *Erythraea diffusa* of Joseph Woods, who discovered it near Morlaix, in Brittany. It occurs on the edge of a headland near Newport, Pembroke.—Prof. R. C. **McLean**: Sex and soma. The author enlarged upon the recently discovered phase of multinucleosis in the developing soma cell of higher plants. The genetic interest of the phenomenon has not received sufficient consideration, and the present paper was designed to direct attention to the possibilities involved.

Aristotelian Society, December 1.—Prof. Wildon Carr, vice-president, in the chair.—G. **Cater**: The nature of inference. The logic of the concrete universal as the medium of judgment and inference was criticised. It was shown by analysis of examples that it does not really succeed in making contact with its differences; their content is only *imputed* to it. On the other hand, the instrument of inference is always an intermediating representation, particular and not universal. Absolutism, the outcome of the theory that the active dominant concrete universal is the instrument of inference, ends in the concept of reality, under the form of eternity, as an exhaustive system of differences, without character, a contentless limit.

PARIS.

Academy of Sciences, November 24.—M. Léon Guignard in the chair.—L. **Maquenne** and E. **Demoussy**: The richness in copper of cultivated soils. The soils examined were in two classes, ordinary arable soil and soil on which fruit-growing had been carried out, and which was therefore liable to contain copper from the liquids used for spraying. All the soils contained copper, but the arable soils some millionths only of their weight. The soil from vineyards was compared with soil from the same district untreated with preparations, and the results from a considerable number of districts are tabulated. One fact was brought out by these investigations: the copper applied in spraying is mainly found in the surface layers, and penetrates the ground with great difficulty. At 30 cm. below the surface the soil of a vineyard contains no more copper than soil from a similar depth in a field growing cereals.—A. **Blondel**: The amplitude of the oscillating current produced by audion generators.—Ch. D. Walcott was elected a foreign associate in succession to the late M. Metchnikoff.—E. **Kogbetliantz**: The unicity of ultra-spherical developments.—L. E. J. **Brouwer**: The classification of closed ensembles situated on a surface.—M. **Portevin**: Study of the influence of various factors on the creation of internal longitudinal strains during the rapid cooling of steel cylinders. The determination of the internal longitudinal strains was carried out by measuring the variations in length produced during the removal of concentric layers of the cylinder by turning. The strains produced depend on a number of factors, including the temperature of immersion, the nature of the liquid (oil, water), the temperature of the water, time of immersion, and diameter of the cylinders. The results are summarised qualitatively in the present communication; full numerical data will be published elsewhere.—R. **Bayeux**: The ozogenic power of the solar radiation at the altitude of the Mont Blanc Observatory. At an altitude of 4360 metres sunlight does not produce ozone from oxygen. Hence it is concluded that the ozone found at lower altitudes is not formed by the direct action of the sun, and the therapeutic effects of the sun-cure cannot be attributed to ozone.—E. **Henriot**: The calculation of double refraction.—M. **de Broglie**: The X-ray spectrum of tungsten.—MM. **Ledoux-Lebard** and A. **Dauvillier**: The reticular distance of calcite and its influence on the determination of *h*. A recalculation of some data given in an earlier communication.—G. **Baume** and M. **Robert**: Some properties of pure nitrous anhydride and of its solution in nitrogen peroxide. The fusibility diagram of the system ($N_2O_3-N_2O_4$) is normal, with a single eutectic near the freezing point of pure nitrogen peroxide. Pure nitrous anhydride does not appear to be capable of existence except at very low temperatures in the solid state, or in the liquid state under a pressure of nitric oxide. At temperatures above $-100°$ C. N_2O_3 dissociates, the liquid phase containing N_2O_4, and the gaseous phase NO.—W. A. **Noyes**, jun.: The potential necessary for electrolysing solutions of iron. In a cell composed of iron anode and cathode and a solution of a ferrous salt absolutely free from ferric salt, it is impossible to deposit iron with a lower voltage than 0·66 volt. This is reduced by increase of temperature, falling to a minimum value of 0·13 at 109° C.—L. **Chelle**: The detection and estimation of traces of hydrocyanic and thiocyanic acids in a complex medium. Hydrocyanic acid can be completely removed by a rapid current, and retained by washing the air with alkali. Chromic acid converts thiocyanic acid into hydrocyanic acid. The results of quantitative experiments are given.—A. **Goris** and Ch. **Vischniac**: The constitution of primeverose, primeverine, and primulaverine.—J. **Bougault** and P. **Robin**: The oxidation of the hydramides. A study of the oxidation of benzhydramide, anishydramide, and piperhydramide by iodine and sodium carbonate. The corresponding cyanidine is produced in each case.—G. **Mouret**: Some effects of the lamination of rocks observed in the western part of the Central Massif of France.—P. **Morin**: The coefficients of flow of the watercourses in the Central Massif.—M. **Dechevrens**: Modification and complement to the method of observation of telluric currents with the aid of naked subterranean conductors.—L. **Daniel**: Experimental researches on the causes of the immersion of the leaves of the water-lily. The immersion of the leaves instead of floating on the surface is not due, as has been suggested, to the effect of the depth of water.—M. **Molliard**: The action of acids on the composition of the ash of *Sterigmatocystis nigra*.—H. **Guilleminot**: The second postulate of the calculus of probabilities and the law of option in the evolution of living matter.—L. **Boutan**: The rotation of the anal region of the larval shell in Gasteropods.—A. **Pézard**: The modifying factor of normal growth and the law of compensation.—M. **Barthélémy**: The definite survival of dogs bled white, obtained by a means other than blood transfusion. The solution injected was a 6 per cent. solution of gum arabic containing 6 parts of sodium chloride per 1000.

SYDNEY.

Linnean Society of New South Wales, September 24.—Mr. J. J. Fletcher, president, in the chair.—K. G. **Blair**: Notes on the Australian genus Cestrinus, Er. (fam. Tenebrionidæ), and some allied genera. The paper discusses the synonymy of the somewhat obscure genus Cestrinus, Er. (fam. Tenebrionidæ), as well as Achora, Pasc., and Adelodemus, Haag.—Dr. H. S. H. **Wardlaw**: The venous oxygen content of the alkaline reserve of the blood in pneumonic influenza. The skin of persons suffering from pneumonic influenza often assumes a distinctly bluish or plum-coloured tinge, and several hypotheses have been put forward to account for this. One question which arises is whether this colouring of the skin is a cyanosis in the generally accepted sense of the word, *i.e.* whether the colour is due to an abnormally large

proportion of reduced hæmoglobin in the blood. In the paper the results are given of investigations involving determinations of the oxygen capacity and degree of oxygen saturation of the venous blood of persons suffering from pneumonic influenza; in some cases the acidity and reactivity were determined by means of the hydrogen electrode. The samples of venous blood from cases of pneumonic influenza showed no indication of decreased oxygen capacity or of deficient oxygenation. The concentration of hydrogen ion produced by the addition of a measured quantity of acid showed no indication of acidosis; the alkaline reserve was not reduced.—Dr. R. J. **Tillyard**: The Panorpoid complex. Part 3: The wing-venation. Amongst the new discoveries may be mentioned the proof that the basal cell of the forewing in the butterflies is an *areocel* of very specialised construction, and that all the higher groups have had the venation of the anal area of the hindwing reduced, not by loss of 3A, as hitherto supposed, but by loss of 1A after fusion with 2A to form a Y-vein. A summary is given of the phylogenetic results, and a phylogenetic table with the positions of the more important fossils marked along the lines of descents. The Trichoptera and Lepidoptera are shown to be very closely allied, being a true dichotomy from a common ancestral stem, probably in the Trias. The Megaloptera and Planipennia are even more closely allied, and can only doubtfully be kept as separate orders. The Diptera are traced back to the Triassic Paratrichoptera, themselves an early offshoot of the older Mecopterous stem. The three orders Mecoptera, Paratrichoptera, and Diptera differ from all the rest in having the cubitus only two-branched, and thus lie outside the main line of advance of the complex.

BOOKS RECEIVED.

Calculation of Electric Conductors. By W. T. Taylor. Pp. 34. (London: Constable and Co., Ltd.) 10*s.* 6*d.* net.

The Present Position of the Theory of Ionisation. Pp. 178. (London: The Faraday Society.) 12*s.* 6*d.*

Action de la Chaleur et du Froid: Sur l'Activité des Etres Vivants. By G. Matisse. Pp. ii+556. (Paris: E. Larose.)

The Theory of Relativity. By H. L. Brose. Pp. 32. (Oxford: B. H. Blackwell.) 1*s.* 6*d.* net.

Timbers and their Uses. By W. Winn. Pp. vii+333. (London: G. Routledge and Sons, Ltd.) 10*s.* 6*d.* net.

The Adventurer's Handbook: Being the Manual of the Order of Woodcraft Chivalry. Pp. xiv+119. (London: The Swarthmore Press, Ltd.) 2*s.* 6*d.* net.

The Hill of Vision: A Forecast of the Great War and of Social Revolution with the Coming of the New Race. By F. B. Bond. Pp. xxv+134. (London: Constable and Co., Ltd.) 7*s.* 6*d.* net.

The Coal Consumption of Power Plants, and Bonuses for Coal Saving. By R. H. Parsons. Pp. 23. (London: The Electrical Review, Ltd.) 1*s.* net.

Musings of an Idle Man. By Sir R. H. Firth. Pp. xii+359. (London: John Bale, Ltd.) 7*s.* 6*d.* net.

Engineering Descriptive Geometry and Drawing. By Capt. F. W. Bartlett and Prof. T. W. Johnson. 3 parts. Pp. vii+206; v+207–374; v+375–617. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 27*s.* 6*d.* net.

The Psychology of the Future. By E. Boirac. Translated and edited, with an introduction, by W. de Kerlor. Pp. xiii+322. (London: Kegan Paul and Co., Ltd.) 10*s.* 6*d.* net.

Pictorial Atlas of English History. Arranged by E. J. S. Lay. Pp. 48. (London: Macmillan and Co., Ltd.) 1*s.* 6*d.*

Experiments with Plants. By J. B. Philips. Pp. 207. (Oxford: At the Clarendon Press.) 3*s.* net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 18.

ROYAL SOCIETY OF ARTS, at 4.30.—P. J. Hartog: Some Problems of Indian Education.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. J. D. Grant: Tuberculosis of the Larynx: Treatment, especially in the Home.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Adjourned Discussion on A Contribution to the Study of Flotation, H. L. Sulman.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—D. M. W. Hutchison and W. J. Wayte: Electricity in Tin Mining.

CONCRETE INSTITUTE, at 7.30.—M. S. R. Adams: The Use of Elliptical Vaulting as a Primary Factor in Contemporary Architecture.

SOCIETY OF ARCHITECTS, at 8.—Prof. H. Adams: The Need for More Care in Warehouse Design.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street), at 8.—Dr. G. E. Moore: External and Internal Relations.

CHEMICAL SOCIETY, at 8.—Prof. J. Walker: War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes.

FRIDAY, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. W. Burley: Cutting Power of Lathe Turning Tools, Part II.

JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—Sir E. Tennyson d'Eyncourt: The Influence of the War on Engineering (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. J. C. Mottram: The Leucocytic Content in Radium Workers.—Adjourned Discussion on Major Cooper's Paper: The Artificial Stimulation of Muscle, with Demonstration of a New Form of Faradic Coil.

SATURDAY, DECEMBER 20.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital), at 4.30.

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MACMILLAN AND CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters to be addressed to the ***Publishers.***

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.

Telephone Number: GERRARD 8830.